JAMES RIVER BASIN

Virginia and West Virginia

Water and Related Land Resources Report

U.S. DEPARTMENT OF AGRICULTURE

Economic Research Service

Forest Service

Soil Conservation Service

JAMES RIVER BASIN REPORT

VIRGINIA AND WEST VIRGINIA

USDA WATER AND RELATED LAND RESOURCES REPORT

Prepared by

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SUMMARY

This report by the United States Department of Agriculture is part of a comprehensive plan to facilitate the coordinated and orderly conservation, development, utilization, and management of the water and related land resources of the James River Basin in Virginia and West Virginia. The Economic Research Service, the U.S. Forest Service and the Soil Conservation Service participated in this study at the request of the U.S. Department of the Army, Corps of Engineers. Careful consideration was given to coordinate efforts between local, State, and Federal agencies involved with water and related land resource planning in the area.

Objective and Scope of the Study

The primary objective of this study was to develop: (1) an inventory of upstream impoundment sites which have potential to meet requirements for flood protection, recreation, water supply, and related use; (2) an appraisal of land treatment problems and needs; (3) water needs for livestock, rural domestic use, recreation, fish and wildlife, water quality management, and irrigation; and (4) potential projects and suggested levels of development to meet the identified needs for water and related land resource development in upstream watersheds. Structural and land treatment mesasures needed in potential upstream projects were identified and further study was made to determine their economic feasibility.

Description of the Basin

The James River Basin comprises 6,442,400 acres with 6,394,300 acres in Virginia and 48,100 acres in West Virginia. The Basin drains approximately 25 percent of central Virginia and less than 1 percent of West Virginia. The James River rises in the highlands near the Virginia-West Virginia line and flows generally eastward thru the cities of Covington, Lynchburg, and Richmond to the Chesapeake Bay at Newport News, Virginia. Figure 1 shows the Conservation Needs Inventory[1/] "small watershed" delineations. Figure 2 indicates the

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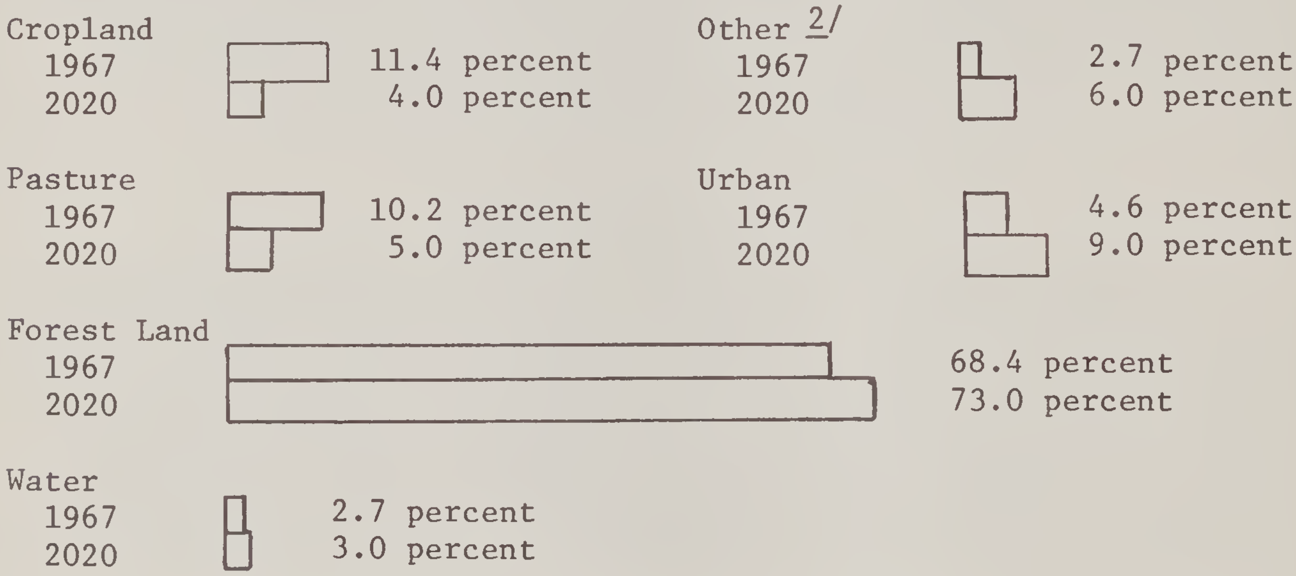
1/ The CNI includes tabulations of agricultural and forest lands by capability class and use, acres on which needed conservation measures have been applied, and additional acres needing conservation treatment. Other tables list the number of hydrologic units or subwatersheds under 400 square miles in area and indicate the kinds and extent of problems needing project action in these subwatersheds.

geologic history and ground water potential. Figure 3 provides a general picture of the topographic variations. Figure 4 presents climatic data. Figure 5 shows the physiographic provinces which generally define the subarea study groupings of CNI subwatersheds. Subarea I conforms generally to the Ridges and Valleys. The Blue Ridge and Piedmont provinces were combined as Subarea II. With slight modifications along subwatershed hydrologic boundaries, Subarea III conforms to the Coastal Plain province. Figure 6 shows the soil series and distribution in the Basin.

Problems and Needs

Improper use, mismanagement and the lack of proper treatment cause most of the problems related to land and water resources. Despite the considerable progress in agricultural land use and conservation treatment in the past 40 years, 2.4 million acres need additional conservation treatment. The problems in urbanizing areas are more acute, though not as extensive as in the agricultural sector. Graph S-1 shows that urban areas will more than double by the year 2020. A similar increase in the "Other" land use classification is indicated. Scattered rural development included in this category have similar problems to those of large scale urban developments.

Graph S-1. Land use trends, James River Basin, 1967-2020[1/]



1/ Source: 1967 data based on Conservation Needs Inventory (see footnote, page S-1) hydrologic boundaries; 2020 data correlated with Economic Research Service projections by generalized county boundaries.

2/ "Other" category also includes such uses as marshes and idle land, but the increase will be largely due to additional rural residential, rural roads, etc.

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FIGURE 1

JAMES RIVER BASIN

VIRGINIA AND WEST VIRGINIA

LEGEND

W'S No.	NAME	W'S No.	NAME	W'S No.	NAME	W'S No.	NAME
12-1	BACK CREEK	12-28	PEDLAR RIVER	12-55	FALLING CREEK	12b-4	MDORMANS RIVER
12-2	JACKSON RIVER 3	12-29	JAMES RIVER 4	12-56	CHICKAHDMINY RIVER 2	12b-5	BEAVER CREEK
12-3	OGLE CREEK	12-30	HARDWARE RIVER	12-57	JAMES RIVER 12	12b-6	MECHUM RIVER
12-4	OUNLAP CREEK	12-31	RUCKER RUN	12-58	CHICKAHOMINY RIVER 3	12b-7	PRIDDY CREEK
12-5	CDVE CREEK	12-32	HARRIS CREEK	12-59	JAMES RIVER 13	12b-8	RIVANNA RIVER 1
12-6	JACKSDN RIVER 1	12-33	IVY CREEK	12-60	JAMES RIVER 14	12b-9	MECHUNK CREEK
12-7	JACKSON RIVER 2	12-34	JAMES RIVER 7	12-61	JAMES RIVER 15	12b-10	RIVANNA RIVER 2
12-8	JACKSON RIVER 4	12-35	JAMES RIVER 6	12-62	JAMES RIVER 16	12b-11	RIVANNA RIVER 3
12-9	POTTS CREEK 3	12-36	JAMES RIVER 5	12-63	JAMES RIVER 17	12b-12	NDRTH FORK RIVANNA RIVER
12-10	POTTS CREEK 2	12-37	JAMES RIVER 8	12-64	JAMES RIVER 18	12b-13	SDUTH FDRK RIVANNA RIVER
12-11	POTTS CREEK 1	12-38	SLATE RIVER 2	12-65	NANSEMDND RIVER	12b-14	IVY CREEK
12-12	BULLPASTURE RIVER	12-39	MUODY CREEK	12-66	BLACKWATER CREEK		APPOMATTDX RIVER
12-13	COWPASTURE RIVER 1	12-40	SLATE RIVER 1	12-67	PICKETT CREEK	12c-1	APPDMATTOX RIVER 1
12-14	CDWPASTURE RIVER 2	12-41	BENT CREEK		MAURY RIVER	12c-2	BUFFALD CREEK
12-15	JACKSON RIVER 5	12-42	WRECK ISLAND CREEK			12c-3	APPOMATTDX RIVER 2
12-16	JAMES RIVER 1	12-43	BEAVER CREEK	12a-1	CALFPASTURE RIVER	12c-4	BUSH RIVER
12-17	CRAIG CREEK 2	12-44	BYRD CREEK	12a-2	LITTLE CALFPASTURE RIVER	12c-5	APPDMATTDX RIVER 3
12-18	JOHNS CREEK	12-45	WILLIS RIVER	12a-3	HAYS CREEK	12c-6	FLAT CREEK
12-19	CRAIG CREEK 1	12-46	LICKINGHOLE CREEK	12a-4	MAURY RIVER	12c-7	SWIFT CREEK
12-20	JAMES RIVER 3	12-47	JAMES RIVER 9	12a-5	BUFFALO CREEK	12c-8	APPOMATTDX RIVER 4
12-21	JAMES RIVER 2	12-48	MUDOY CREEK	12a-6	SOUTH RIVER	12c-9	OEEP CREEK
12-22	CATAWBA CREEK	12-49	DEEP CREEK		RIVANNA RIVER	12c-10	NAMOZINE CREEK
12-23	NORTH FDRK ROCKFISH RIVER	12-50	BEAVERDAM CREEK			12c-11	APPOMATTDX RIVER 5
12-24	ROCKFISH RIVER	12-51	JAMES RIVER 10	12b-1	SWIFT RUN	12c-12	VAUGHANS CREEK
12-25	TYE RIVER	12-52	TUCKAHDE CREEK	12b-2	RDACH RIVER	12c-13	NIBBS CREEK
12-26	PINEY RIVER	12-53	CHICKAHOMINY RIVER 1	12b-3	BUCK MDUNTAIN CREEK	12c-14	CELLAR CREEK
12-27	BUFFALO RIVER	12-54	JAMES RIVER 11				

March 1973

USDA-SCS-HYATTSVILLE, MD. 1973

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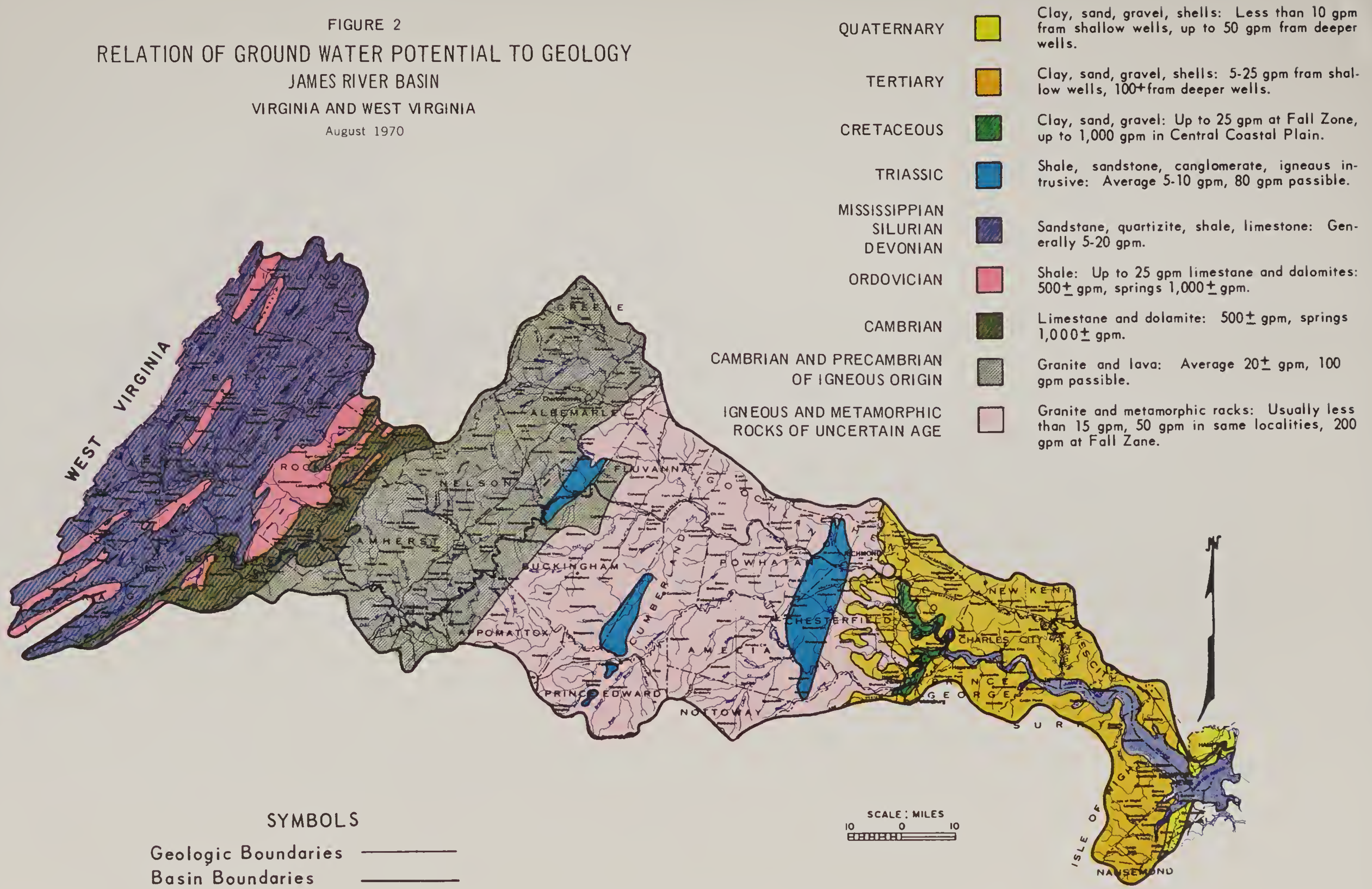
FIGURE 2

RELATION OF GROUND WATER POTENTIAL TO GEOLOGY

JAMES RIVER BASIN

VIRGINIA AND WEST VIRGINIA

August 1970



Source: Virginia Department of Conservation and Economic Development
Division of Water Resources

USDA-SCS-HYATTSVILLE, MD. 1971

U. S. DEPARTMENT OF AGRICULTURE
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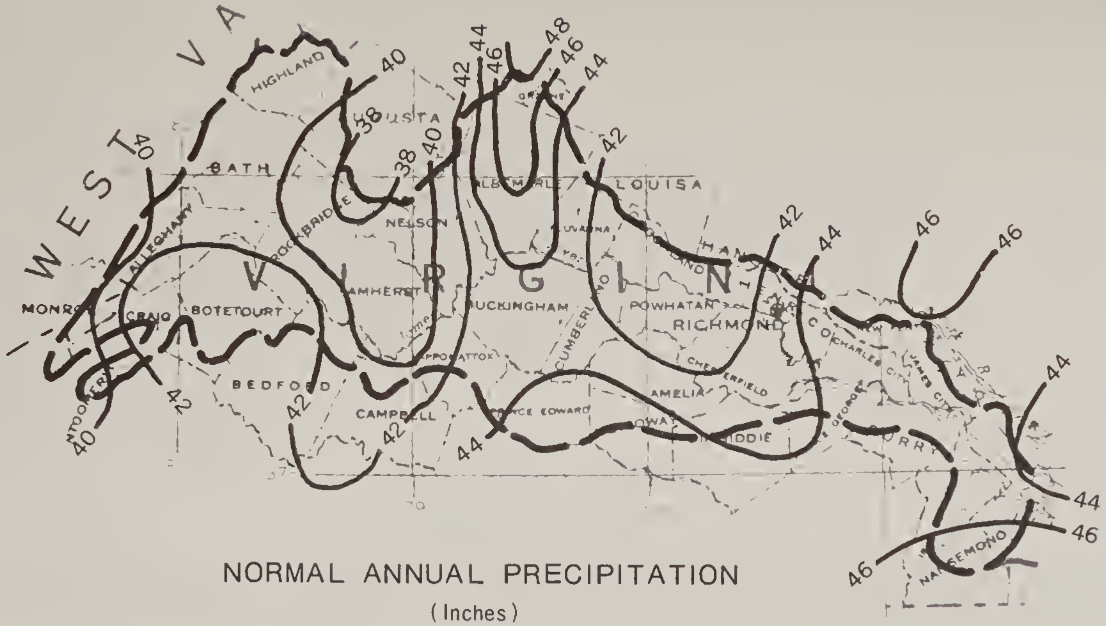
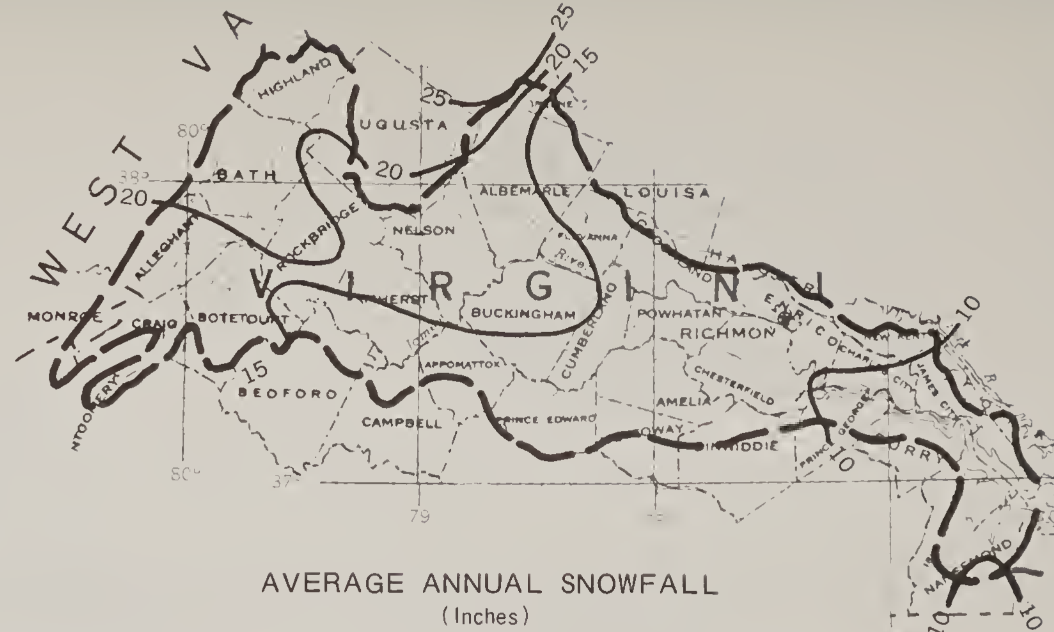
FIGURE 3
TOPOGRAPHIC MAP
JAMES RIVER BASIN
VIRGINIA AND WEST VIRGINIA
August 1970

Source: Virginia Department of Conservation and Economic Development
Division of Water Resources

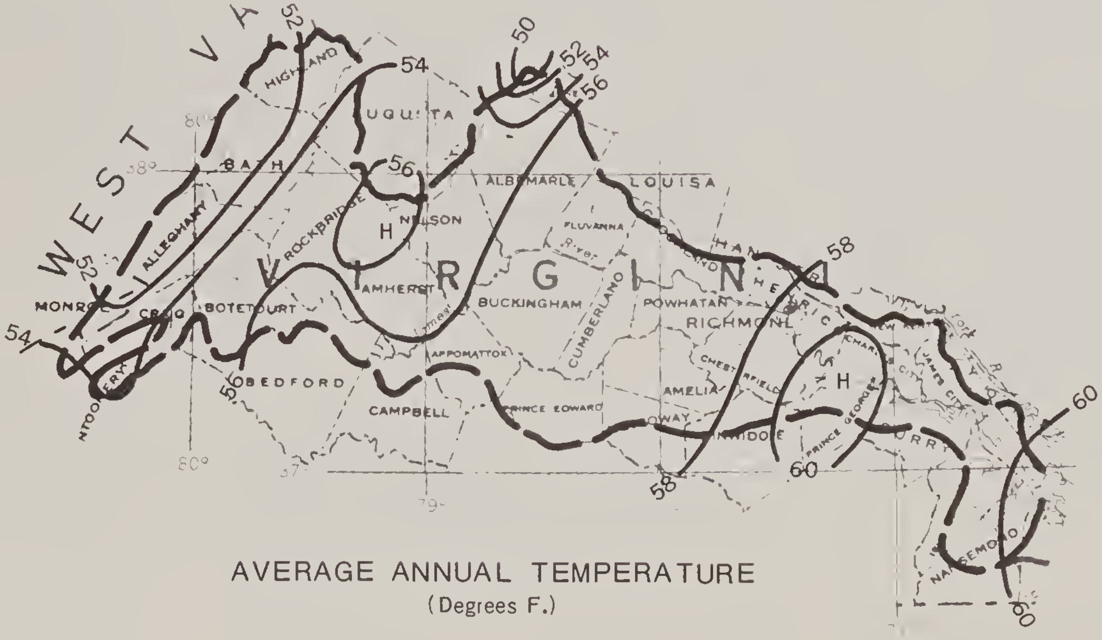
USDA-SCS-HYATTSVILLE, MD. 1970



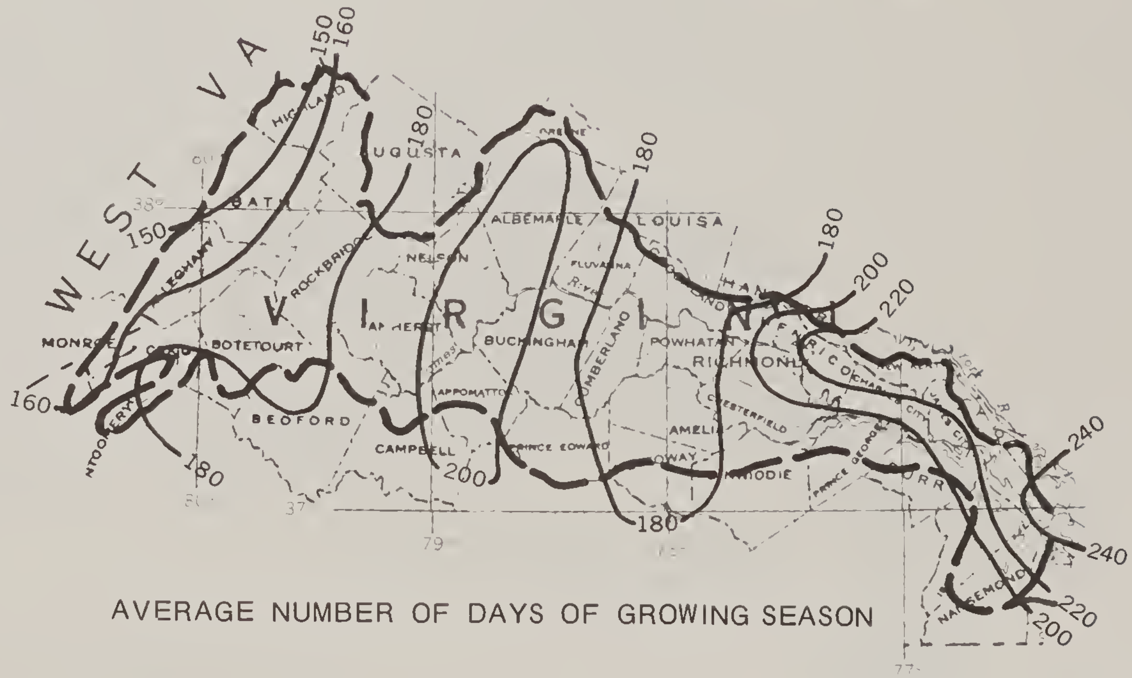
NORMAL ANNUAL PRECIPITATION
(Inches)



AVERAGE ANNUAL SNOWFALL
(Inches)



AVERAGE ANNUAL TEMPERATURE
(Degrees F.)

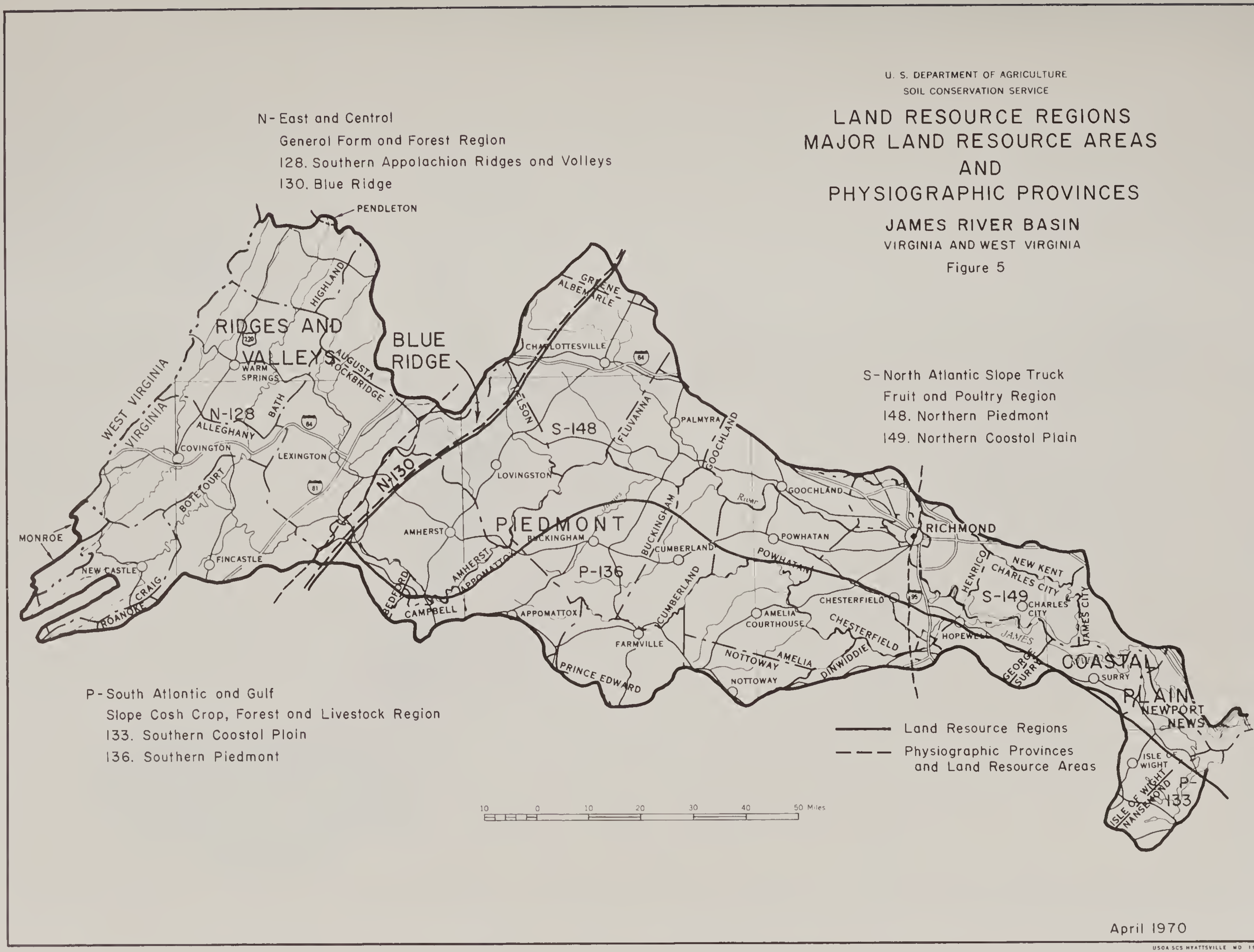


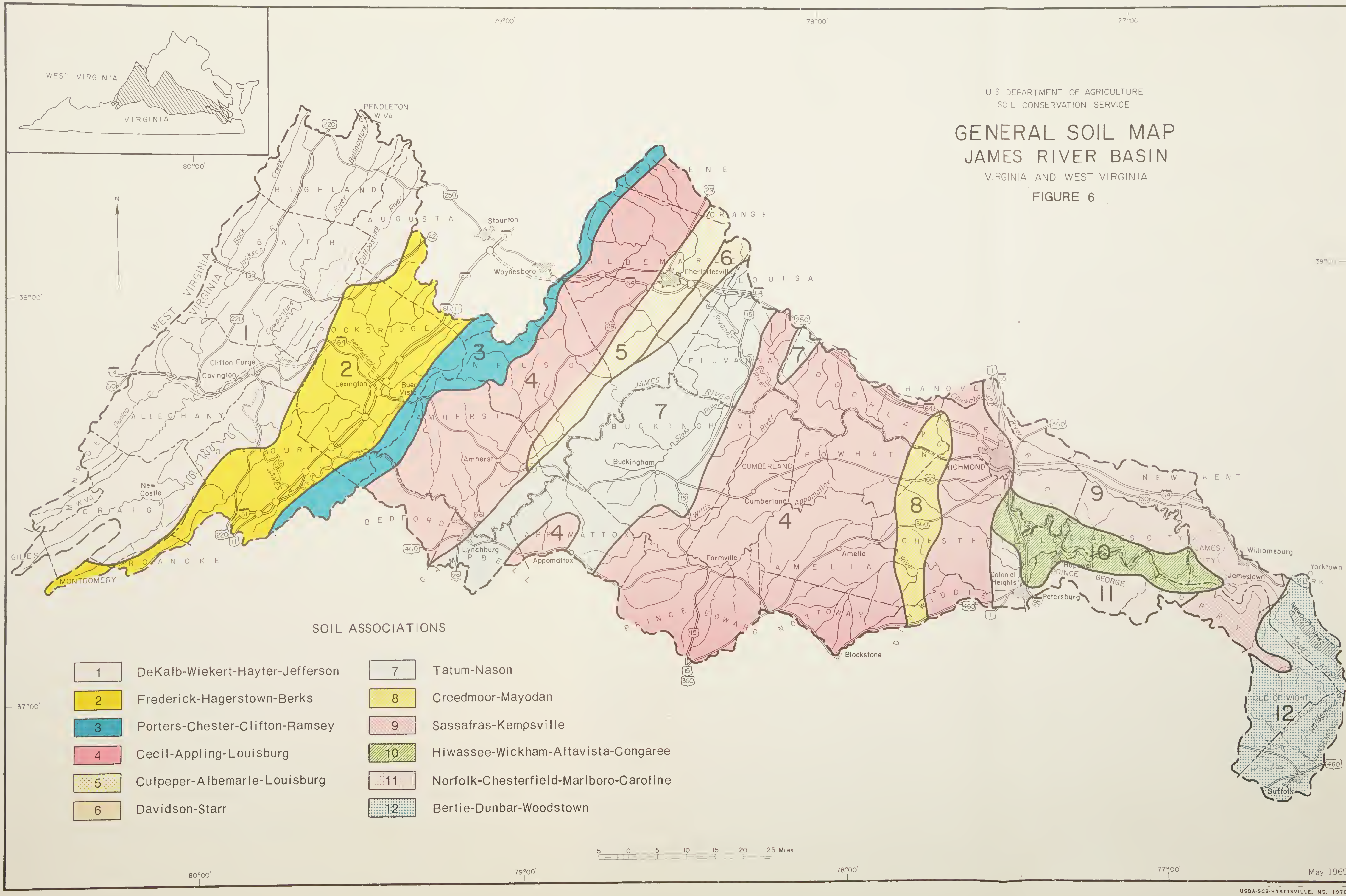
AVERAGE NUMBER OF DAYS OF GROWING SEASON

FIGURE 4

JAMES RIVER BASIN

VIRGINIA, WEST VIRGINIA


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
LAND RESOURCE REGIONS
MAJOR LAND RESOURCE AREAS
AND
PHYSIOGRAPHIC PROVINCES
JAMES RIVER BASIN
VIRGINIA AND WEST VIRGINIA
Figure 5
N - East and Central
General Farm and Forest Region
128. Southern Appalachian Ridges and Valleys
130. Blue Ridge
S - North Atlantic Slope Truck
Fruit and Poultry Region
148. Northern Piedmont
149. Northern Coastal Plain
P - South Atlantic and Gulf
Slope Cash Crop, Forest and Livestock Region
133. Southern Coastal Plain
136. Southern Piedmont
Land Resource Regions
Physiographic Provinces
and Land Resource Areas
10 0 10 20 30 40 50 Miles
RIDGES AND VALLEYS
BLUE RIDGE
PIEDMONT
COASTAL PLAIN
N-128
N-130
S-148
S-149
P-136
P-133
WEST VIRGINIA
VIRGINIA
PENDLETON
HIGHLAND
AUGUSTA
ROCKBRIDGE
BATH
ALLEGHANY
WARM SPRINGS
COVINGTON
LEXINGTON
BOTETOURT
MONROE
NEW CASTLE
CRAIG
ROANOKE
FINCASTLE
BEDFORD
CAMPBELL
AMHERST
APPOMATTOX
NELSON
LOVINGSTON
GREENE
ALBEMARLE
CHARLOTTESVILLE
FLUVANNA
PALMYRA
GOOCHLAND
BUCKINGHAM
CUMBERLAND
FARMVILLE
PRINCE EDWARD
NOTTOWAY
AMELIA
AMELIA COURTHOUSE
POWHATAN
CHESTERFIELD
DINWIDDIE
RICHMOND
HENRICO
NEW KENT
CHARLES CITY
JAMES CITY
HOPEWELL
JAMES
River
PRINCE GEORGE
SURRY
NEWPORT NEWS
ISLE OF WIGHT
NANSEMOND
April 1970
USDA SCS HYATTSVILLE MD 1970


U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
GENERAL SOIL MAP
JAMES RIVER BASIN
VIRGINIA AND WEST VIRGINIA
FIGURE 6
SOIL ASSOCIATIONS
1 DeKalb-Wiekert-Hayter-Jefferson
2 Frederick-Hagerstown-Berks
3 Porters-Chester-Clifton-Ramsey
4 Cecil-Appling-Louisburg
5 Culpeper-Albemarle-Louisburg
6 Davidson-Starr
7 Tatum-Nason
8 Creedmoor-Mayodan
9 Sassafras-Kempsville
10 Hiwassee-Wickham-Altavista-Congaree
11 Norfolk-Chesterfield-Marlboro-Caroline
12 Bertie-Dunbar-Woodstown
WEST VIRGINIA
VIRGINIA
PENDLETON W VA
HIGHLAND
AUGUSTA
BATH
ROCKBRIDGE
ALLEGHANY
BOTETOURT
CRAIG
ROANOKE
MONTGOMERY
GILES
BEDFORD
CAMPBELL
APPOMATTOX
AMHERST
NELSON
ALBEMARLE
GREENE
ORANGE
LOUISA
FLUVANNA
BUCKINGHAM
CUMBERLAND
POWHATAN
GOOCHLAND
HANOVER
HENRICO
CHESTERFIELD
AMELIA
NOTTOWAY
PRINCE EDWARD
DINWIDDIE
PRINCE GEORGE
CHARLES CITY
NEW KENT
JAMES CITY
SURRY
YORK
ISLE OF WIGHT
NANSEMOND
Stounton
Waynesboro
Charlottesville
Clifton Forge
Covington
Lexington
Buena Vista
New Castle
Amherst
Lynchburg
Appomattox
Buckingham
Cumberland
Farmville
Amelia
Blackstone
RICHMOND
Colonial Heights
Petersburg
Hopewell
Williamsburg
Jamestown
Yorktown
Suffolk
JAMES RIVER
N
5 0 5 10 15 20 25 Miles
May 1969
USDA-SCS-HYATTSVILLE, MD. 1970

Erosion and sedimentation problems resulting from Hurricane Camille in 1969.

Needed operations have been completed in this area to restore pre-hurricane flow capacity and vegetative cover.

Two years later, restored channel again allows productive use of flood plain. Vegetation aids in control of streambank erosion and in restoration of fish and wildlife values.

Jackson River at Covington, Lickinghole Creek near Crozet, and on the main stem of the James River below Lynchburg and Richmond.

Needs for drainage exists on 579,300 acres of agricultural lands. These needs can be met by individual landowners with assistance available under present USDA programs. Both surface and internal drainage is needed on scattered areas along the tributaries throughout the Basin. There is a need in the Basin for regulation to prevent indiscriminate drainage of wetland wildlife habitat by developers and others. Additional study of potential drainage and channel improvement projects is needed to minimize possible adverse environmental impacts.

Estimates for acreage needing irrigation, listed consecutively for 1980, 2000, and 2020, are 22,000, 56,900, and 98,000 acres. Irrigation requirements in the Basin will generally be met until the year 2006 by landowners with assistance under ongoing programs. Water storage to meet irrigation needs is being provided in farm ponds where stream flow is inadequate or unavailable. Group irrigation projects are not applicable in the Basin.

Sport fishing pressure will double by the year 2020. About 160,000 acres of new fresh water reservoirs will be needed to meet this demand. Facilities and opportunities for other recreational

activities are already in short supply. This deficit will become increasingly larger for the foreseeable future despite special efforts toward meeting these needs. The problem is compounded by the lack of adequate public access to areas suitable for water oriented activities in the lower Basin and a shortage of such areas in the Piedmont and upper Basin. Other complications involve the need for facilities to be located near densely populated areas and competition for land and water resources for other uses.

Findings and Conclusions

Development Potential

Land and water will not be limiting factors in resource development in the Basin. About 2.7 acres of land per capita will be available to meet the needs of the projected population in the year 2020. Average surface water yields will provide about 2,000 gallons per day per capita for the 2020 population. Ground water developments could add an estimated 500 gpd per capita. Traditional economic, social, and political factors will be the limiting factors in achieving desirable environmental patterns, optimum use, and proper management of these resources.

About 600 sites in upstream watersheds provide potential for development to meet needs for flood control, water supply, recreation, wildlife, and similar needs. Table S-1 summarizes data of drainage area, storage, and surface area potential on these sites. Sixty-one of the sites were determined to have outstanding storage potential. Data on these sites is provided in Table S-2.

An estimated additional 10,000 smaller sites are available for development of one-acre to 10-acre water storage ponds. Such development would make an estimated 30,000 surface acres available for family-type recreation. Single or multipurpose use would provide about 200,000 acre-feet of storage for irrigation, water for livestock or wildlife, fire control, and similar purposes.

The resources of the Basin afford the potential for irrigation, drainage, and other efficiencies to meet the needs for production of food and fiber and other material necessities. Also, the physical potential is available to provide most of the wants of the people for recreation, fish and wildlife, visual quality, parks, green belts, and other demands that might be categorized as "environmental amenities".

Opportunities for Development under USDA Programs

Opportunities available under long established USDA programs will allow broader application of proven tools and techniques in adapting land use to capability throughout the Basin. Concepts such as multiobjective planning will provide further opportunities for

Table S-1. Summary of reservoir storage potential, James River Basin

Physiographic Province	Drainage Area (Sq. Mi.)	Number of Pot. Sites	D.A. Above Sites (Sq. Mi.)	Storage Potential by Purpose			Surface Area 1/ (Acres)
				Flood & Sediment (Ac.Ft.)	Beneficial 2/ (Ac.Ft.)	Total (Ac.Ft.)	
Ridges and Valleys	3,038.9	245	1,470.9	332,450	1,077,435	1,409,435	33,130
Blue Ridge & Piedmont	4,948.1	315	2,473.2	683,205	1,652,035	2,340,290	103,210
Coastal Plain	2,079.2	27	151.1	36,815	91,965	128,780	6,651
TOTAL	10,066.2	587	4,095.2	1,052,470	2,821,435	3,875,955	142,991

1/ Surface area at elevation of emergency spillway.

2/ Based on percentage of average annual watershed yield used in North Atlantic Water Resources Study.

Source: Table VII-2 in body of this report.

Table S-2. Summary of outstanding storage potential sites, James River Basin

Physiographic Province	Number of Sites	Total Drainage Area (Sq. Mi.)	Total Storage (Ac.Ft.)	Surface Area at Maximum Pot. Development (Acres)
Ridges and Valleys	9	324.7	251,950	6,590
Blue Ridge & Piedmont	47	1,091.1	955,730	42,840
Coastal Plain	5	66.7	56,240	4,130
Total Basin	61	1,482.5	1,263,920	53,560

Source: Table VII-3 in the body of this report.

coordination with other agency programs in achieving proper management of land and water resources. The discussion which follows is devoted primarily to opportunities for meeting needs of the Basin under Public Law-566 projects.

Screening-type investigations were made on each of the 101 CNI subwatersheds delineated in the Basin. It was determined that on 53 of the subwatersheds, problems and needs could best be met by improved land treatment, flood plain management, and other non-structural measures. Needs for single purpose reservoirs for recreation, water supply, or other measures would not be implemented under Public Law-566 authorizations in these subwatersheds.

Twenty-six projects comprising the 48 remaining CNI watersheds were found to be potentially feasible for development under Public Law-566. Twelve of these projects were selected for "early action" priority on the basis of need, local interest, and other factors. It is suggested that these projects be installed by the year 1980. Installation of nine of the projects would be recommended for priority during the period 1980 to 2000 (intermediate range). Five of the projects were assigned long-range priority and scheduled for development in the 2000 to 2020 period. Tables S-3 and S-4 summarize land treatment and structural data at the suggested level of development to meet identified needs. In Table S-5, cost estimates for structural measures in each priority category are shown with average annual cost amortized at 5-5/8 percent for the 100-year economic life of the structures. Figure 13 in Chapter VIII shows the location of the projects and PL-566 projects already installed or authorized for installation.

Table S-3. Summary of estimated acreage and land treatment cost, PL-566 Projects, James River Basin

Priority Category	Crop-land	Pasture-land	Forest land	Critical Areas 3/	Total	Cost (Dollars)		
						P.L.566 1/	Other 2/	Total
	Acres							
Early Action	29,330	77,900	79,960	2,740	189,930	914,700	4,080,400	4,995,100
Intermediate Action	38,440	49,770	100,030	2,060	190,300	697,400	3,185,300	3,882,700
Long Range	23,640	10,130	61,200	1,130	96,100	415,200	1,321,600	1,736,800
Total	91,410	137,800	241,190	5,930	467,330	2,027,300	8,587,300	10,614,600

1/ Cost for accelerated land treatment.

2/ Cost to landowners, PL-46 and related programs.

3/ Areas of severe sheet or gully erosion.

Table S-4. Structural summary data, PL-566 Projects, James River Basin

Priority Category	Structural Data								Normal Pool	Channel Improv.	Unallocated Storage
				Allocated Storage 2/							
	W/S-D.A. 1/	Structural Sites	D.A. Above Sites	Sediment	Flood	Supply	Rec.	Total			
	Sq.Mi.		Sq.Mi.		Acre	Feet			Acres	Miles	Ac.-Ft.
Early Action	1798.1	57	678.0	25,375	144,755	16,785	48,785	235,220	3,835	42.2	296,125
Intermediate Action	1696.8	45	885.3	40,290	205,205	20,870	85,930	325,295	7,811	98.1	323,365
Long Range Action	813.1	17	303.9	16,205	58,485	4,000	48,170	126,860	4,315	101.3	109,905
Total	4208.0	119	1,867.2	81,870	408,445	41,175	182,885	714,375	15,961	241.6	729,935

1/ Watershed Drainage Area

2/ At suggested level of development to meet identified needs.

Table S-5. Summary of structural cost data, PL-566 Projects, James River Basin

Priority Category	Installation Cost[1]						
	Flood Prevention	Water Supply	Recreation	Total Installation	Average Annual Installation	Average Annual O&M	Total Average Annual
	Thousands of Dollars						
Early Action	30,111.0	3,065.6	7,909.1	41,085.7	2320.9	329.0	2649.9
Intermediate Action	31,211.7	2,508.9	15,078.8	48,799.4	2756.6	833.8	3590.4
Long Range	12,773.8	408.0	7,551.7	20,733.5	1171.3	410.1	1581.4
Total	74,096.5	5,982.5	30,539.6	110,618.6	6248.8	1572.9	7821.7

1/ Price Base 1967. At suggested level of development to meet identified needs.

2/ Amortized at 5-5/8 percent interest rate and 100-year economic life.

Impacts of USDA Programs

General

Impacts of land use and conservation treatment under long established USDA programs will continue to be realized throughout the Basin. The overwhelmingly net favorable effects of these measures has not been questioned.

Recently, public criticism has alleged widespread and severe adverse effects from certain practices, particularly channel improvement for flood protection. This has resulted in a strengthening of procedural safeguards to assure that a full evaluation of the benefits and effects of these practices is made available to the decision makers.

The 12 projects in the early action priority category are suggested for installation by 1980 under Public Law-566 authorization. Because of the probable modification and possible elimination of some of the intermediate and long-range projects prior to implementation, no evaluation of probable impacts of these projects was made for some of the items discussed below.

Impacts of Early Action Projects

Hydrology. Accelerated land treatment and structural measures of the potential PL-566 projects would eliminate or reduce depths of flooding for 100-year and 5-year storms as indicated in Table S-6.

Table S-6. Flood plain acres inundated with and without proposed PL-566 projects, James River Basin

Priority Category	Flood plain inundated (acres)			
	By 100-year flood		By 5-year flood	
	w/o Project	w/Project	w/o Project	w/Project
Early Action (by 1980)	25,190	17,680	17,430	7,640
Intermediate Action (by 2000)	24,785	17,690	18,565	855
Long Range Action (by 2020)	21,300	17,075	17,245	150
TOTAL (1980-2020)	71,275	51,445	53,240	8,645

Source: Watershed Investigation Reports.

Erosion and Sedimentation. In the 12 early action projects, the 190,000 acres of accelerated land treatment would reduce the annual soil loss by about 20 percent or an estimated 150,000 tons per year.

The 57 single and multipurpose floodwater retarding structures proposed in these projects would provide 25,375 acre-feet of sediment storage or about 50,000 tons of sediment each year during the economic life of the structures.

These measures would reduce sediment damage from floods and enhance fishing, swimming, recreational and other environmental values. The quality of public water supply systems fed by these upstream watersheds will be improved and treatment costs will be reduced.

Fish and Wildlife and Recreation. More favorable biologic conditions would result from reduced erosion and sedimentation. Increased food supplies and more diverse habitat would result from improved forest management and other conservation measures.

In the 12 early action projects at suggested levels of development, existing fish and wildlife and other existing environmental values would be lost in 3,835 acres in normal pool and construction areas of floodwater and multipurpose reservoirs. These areas represent about .3 of 1 percent of the total area of these subwatersheds. About 15 miles of put-and-take trout streams and 15 miles of warm water stream fisheries would be flooded by these pools. Another 15 miles of streams in these pools afford little or no fishing because of undependable flows.

Another 4,733 acres of wildlife habitat and 25 miles of streams will be subject to intermittent flooding in detention pools. Existing ecosystem will be disrupted.

The normal pools (consisting of 3,835 acres) will be available for recreational use. Some of the reservoirs will afford opportunities for development as put-and-take trout fisheries. Levels of other water oriented recreation will depend on availability for public access and supporting development at individual sites.

Channel Improvements. About 42 miles of channel improvements appear to be needed in the early action projects to meet tentative five year flood protection objectives. Prior to implementation, channel improvement measures will be reexamined to determine if measures can be modified or eliminated. Final specifications will include other measures and requirements to minimize or mitigate adverse environmental impacts.

Economic Impacts. Table S-7 shows a summary of monetary benefits attributable to structural measures by priority category for the 26 potential PL-566 projects. Table S-8 provides a comparison

Floodwater retarding structure at 100-year frequency design stage doing its job of storing required floodwater.

Photo shows design outflow of structure.

Table S-7. Summary of average annual benefits, potential PL-566 projects, James River Basin

Priority Category	Average Annual Benefits: Flood Prevention 1/	Water Supply	Recreation	Redevel. & Secondary 2/	Total Benefits
	Thousands of Dollars 3/				
Early Action	1,582.9	153.8	970.2	511.7	3,218.6
Intermediate Action	1,317.6	225.7	2,525.3	498.5	4,467.1
Long Range Action	514.4	19.5	1,413.8	194.8	2,142.5
Total	3,414.9	399.0	4,909.3	1,205.0	9,828.2

1/ Flood prevention benefits includes damage reduction, more intensive land use, changed land use, incidental recreation and benefits to sediment stored in structures.

2/ Broadly, value of benefits from increased economic activity generated as a result of project installation.

3/ Price base 1967.

of the costs and benefits with installation costs amortized at three discount rates and indicates an overall favorable benefit-cost ratio for discount rates up to 7 percent in each priority category. Individual projects will be reevaluated prior to implementation using updated prices, costs, and discount rates where economic justification is questionable, or where project measures or objectives are significantly modified.

Intended Use and Further Coordination

The potentials and opportunities evaluated in this report will be considered as building blocks available for fitting into the overall comprehensive plan for the Basin. Suggested levels of development may be modified or expanded. Opportunities under other agency's programs or private developments may provide more practical solutions to meet the demands of the Basin and preclude the need for or feasibility of specific USDA projects and measures. USDA personnel will be available to aid in selection of recommendations and options to be included in the overall plan.

Table S-8. Summary of comparison of benefits and costs of structural measures[1/], potential PL-566 projects, James River Basin

Priority Category	Average Annual Benefits	Average Annual Costs[2/]			Benefit-Cost Ratio[3/]		
		5-5/8%	5-7/8%	7%	5-5/8%	5-7/8%	7%
	Thousands of Dollars						
Early Action	3,218.6	2,649.9	2,749.7	3,217.7	1.21:1	1.2:1	1.0:1
Intermediate Action	4,467.1	3,590.4	3,710.6	4,253.7	1.24:1	1.2:1	1.1:1
Long Range Action	2,142.5	1,581.4	1,632.3	1,863.1	1.35:1	1.5:1	1.2:1
Total	9,828.2	7,821.7	8,092.6	9,334.5	1.25:1	1.2:1	1.1:1

1/ Price base 1967.

2/ Installation costs amortized for 100-year economic life at indicated discount rates plus annual operation and maintenance.

3/ Economic feasibility evaluations in this report are based on 5-5/8 percent discount rates for amortization of installation costs. 5-7/8 percent and 7 percent columns indicate effects of higher discount rates on benefit-cost ratio.

CHAPTER I

INTRODUCTION

Use to Be Made of Report

This report contributes to a comprehensive study of the James River Basin by the U. S. Department of Army, Corps of Engineers and the U. S. Department of Agriculture. Efforts by both Departments were fully cooordinated to formulate a short term and long term program to meet water and related land resource needs. It provides framework into which projects and programs for resource development can be fitted, with minimal adverse effects to the environment. It will also serve as a guide in planning and coordinating future water and land resource development programs and projects of other local, State and Federal agencies. Consultations were made with other Federal, State and local agencies to insure full consideration of all requirements for the development of these resources.

Authorization

By resolution adopted August 6, 1964, the Committee on Public Works of the United States Senate authorized a review of the report by Chief of Engineers on the James River published as House Document Number 207, 80th Congress, 1st Session. The U. S. Department of Agriculture participated in this review at the request of the U. S. Department of Army, Corps of Engineers under the authority contained in Section 6 of Public Law 83-566, as amended.

Why the Study is Needed

A comprehensive study of this type is necessary to facilitate planning to meet present and future demands for water and related land resources. A projected Basin population of 1.7 to 2.6 million persons[1/] by the year 2020 will require that efficient use be made of all resources.

Competition for land and water makes it imperative that certain controls and restraints be exercised in the use and management of these resources. Data compiled is needed to explain the necessity for these constraints and to assure their acceptance by the people affected.

Description of the Study Area

The James River Basin is a triangular-shaped area which extends southwesterly through the central portion of Virginia (Figure 1).

1/ The population projection falling within this range was used in determining resource needs.

The Basin comprises 6,442,400 acres with 6,394,300 acres in Virginia (99 percent) and 48,100 acres in West Virginia (1 percent). The Basin drains all or part of 39 counties in Virginia and two in West Virginia. The study area represents approximately 25 percent of Virginia. The major tributaries of the James River are the Appomattox, Maury and Rivanna Rivers.

The Jackson and Cowpasture Rivers begin on steep wooded slopes of the Ridges and Valleys physiographic province near the Virginia-West Virginia boundary and flow southward to form the James River near Clifton Forge. The James River then flows easterly 340 miles through the Blue Ridge and Piedmont physiographic provinces, enters the Coastal Plain physiographic province at Richmond, Virginia and empties into the Chesapeake Bay near Newport News at Hampton Roads, Virginia. Over its entire flow the river falls a total of 988 feet.

Climate has influenced land uses and socioeconomic patterns. Approximately 68.4 percent of the land in the James River Basin study area is in forest, 11.4 in cropland, 10.2 in pasture, 4.6 in urban areas, 2.7 in water, and 2.7 in other. Virginia's climate is considered mild and subject to comparatively slight variations within seasons. Moderate variations of tempature and precipitation, however, are experienced between the mountainous and coastal regions of the Basin.

Nature and Objective of Investigation

The report is an inventory type cooperative study. Potentially feasible projects were developed to optimum levels. Impacts were determined using these levels of development for these projects recommended for more detailed study and implementation during the next 10 to 15 years. The objective of the U. S. Department of Agriculture in the survey was to develop information for use in the formulation of plans related to agriculture and rural communities in upstream watersheds less than 250,000 acres in size.

How Study Was Made

The James River Basin study is defined as a Type IV level of investigation. The survey evaluates the overall water and related land resource problems and development potentials. More detailed watershed investigation reports were developed for the basic data files on those watersheds that show project potential for development under Public Law 566 by 1980.

This report contains an inventory of water and related land resources. It provides an economic base and describes problems

and needs, development potentials, opportunities, and alternative solutions to meet present and probable future needs for water and related land resources.

Projections were made by participating agencies to determine the needs for orderly growth and development of the Basin for the years 1980, 2000 and 2020.

Primary consideration was given to the following factors in determining alternative solutions:

1. Programs of land treatment measures to reduce erosion, sediment, and flooding.

2. Feasible upstream watershed projects to include floodwater retarding structures, other beneficial storage, and supplemental channel improvement. An inventory of other physical impoundments was also made.

3. Flood plain management to include zoning and flood insurance, flood proofing, alternate use of flooded areas, and other non-structural measures.

4. Water and related land resource projects and measures to be initiated during the next 10 to 15 years. The size, purposes and cost-sharing arrangements of these projects are compatible with PL-566.

5. Physical and economic impacts resulting from the early action programs. Information obtained and data developed through this study will be used in planning PL-566 watershed projects, resource conservation and development projects, planning in the Appalachian area, and management of the National Forest.

For the purposes of study and evaluation, the Basin was divided into three subareas. Hydrologic units were established using the National Soil and Water Conservation Needs Inventory (Figure 1). Subarea groupings generally conform to the physiographic provinces and major land resource area boundaries (Figure 5). The Blue Ridge physiographic province was incorporated with the Piedmont physiographic province-Subarea 2, except for a very small portion. Its western slopes were incorporated in and evaluated with Ridges and Valleys physiographic province-Subarea 1 (Figure 7). The western part of Chesterfield and Henrico Counties were evaluated as part of the Coastal Plain physiographic province-Subarea 3. Counties were used as the basic unit in establishing the economic base by grouping together those counties with similar socio- and physioeconomic characteristics (Figure 7, p. III-3).

Organization of the Report

This report utilizes a problem-needs-solution format to describe the opportunities for development resulting from the USDA planning

effort. Chapter II describes the natural resource base of the James River Basin, enabling the reader to become familiar with the physical base present for development. Chapter III then follows with a description of the economic base which planners in the Basin have to work with.

Chapter IV initiates the problem-needs-solution sequence with a discussion of the problems which are present in the Basin and for which solutions will be developed. Chapter V then describes the need for development based on the water and related land resource problems, projected economic activity and its effect on water use and quality.

Chapter VI discusses the contributions of existing water and related land resource projects and programs and their significance towards meeting projected needs. Chapter VII describes the development potential existing in the Basin.

Chapter VIII then presents some solutions or opportunities for development under USDA and related programs. Chapter IX follows with a discussion of the impacts of these programs.

USDA Agencies Participating in the Study

The principal participants within the U. S. Department of Agriculture were the Soil Conservation Service, the Forest Service and the Economic Research Service. This coordinated study was under the direction of a Field Advisory Committee, with the SCS representative serving as chairman. The Field Advisory Committee had primary responsibility for: (1) selecting the appropriate Departmental procedures: (2) programming and coordinating Departmental field activities; (3) arranging for necessary consultation with subject matter specialists; (4) coordinating overall field relationships with all agencies having interest in the study; (5) assigning priorities and schedules; (6) arranging for preparation and review of survey findings and interim reports and (7) preparation of the USDA Report. The Committee met at regular intervals to review progress and coordinate efforts of Federal, State and local agencies.

Acknowledgments

Various Federal, State and local agencies cooperated and furnished information for the study and investigation of the James River Basin. The following is a partial list of contributors to the study.

Federal

USDA, Farmers Home Administration
USDA, Agricultural Stabilization and Conservation Service
USDI, Bureau of Sport Fisheries and Wildlife

USDI, Bureau of Outdoor Recreation
USDI, Geological Survey
Department of the Army, Corps of Engineers

State

Soil and Water Conservation Commission
Department of Agriculture and Commerce
VPI & SU Extension Division
Division of State Planning and Community Affairs
Department of Labor and Industry
Division of Industrial Development
Employment Commission
Department of Conservation and Economic Development
Commission of Outdoor Recreation
Commission of Game and Inland Fisheries
Water Control Board

Local

Soil and Water Conservation Districts
County and City Planning Commissions
Local Governing Bodies (County, City and Town)
Chamber of Commerce

CHAPTER II

NATURAL RESOURCES

In the data and discussion that follows, the Basin is described in terms of its location and natural resources in both qualitative and quantitative terms as related to agriculture, rural communities and upstream watershed areas. Sufficient detail is provided to point out the physical characteristics of the Basin. Related economic activity is provided in Chapter III.

Location

The 10,066 square miles of the James River Basin comprises all or parts of 39 counties across the central portion of Virginia and parts of two counties in West Virginia. The 99.3 percent of the Basin in Virginia is about 25 percent of the area of the State. The Potomac, York and Rappahannock Rivers drain areas to the west and north. To the south are portions of the Roanoke and Chowan River Basins. Portions of the Ohio River Basin lie to the south and west.

Climate

The Basin lies in the humid temperate zone of the eastern United States. Rainfall and temperature are such that farm and forest production is generally more than adequate for the needs of the Basin. Seasonal and daily variations afford a stimulating but usually comfortable climate. Violent natural disturbances causing death, extensive damage, or widespread loss of crops are rare, but have occurred twice in recent years.

Precipitation

As shown in Figure 4 the normal annual precipitation is about 43 inches. Severe drought conditions prevailed throughout the Basin in 1930 when precipitation averaged only 25 inches. No wide variations throughout the Basin were noted in 1937 when the high average of 53 inches was recorded.

Slightly more than half of the annual precipitation occurs from April to September. During this period thunderstorms frequently upset normal local patterns. Hurricanes occasionally cause heavy and widespread rainfall. Abrupt and wide variations occur more often in the mountains and Piedmont. The Coastal Plain has registered none of the extremes of precipitation for the Basin, but a record hurricane wind of 78 miles per hour was read at the nearby Norfolk station in 1954.

On August 19-20, 1969 a record 27-inch, 6-hour rainfall was measured a few miles east of the Montebello station in the Blue

Ridge Mountains. The Hot Springs station, deep in the Ridges and Valleys, registered the greatest snow accumulation in one winter of 57 inches.

Temperature and Growing Season

Average temperature in the Basin is about 56 degrees. As would be expected, temperatures in the higher elevations are cooler than in the Piedmont and Coastal Plain (Figure 4).

The Hot Springs area is widely known for its pleasant summer weather with a mean maximum July temperature of 81 degrees and a record high of 98 degrees. The record low in the Basin of -20 degrees was recorded here.

In the Piedmont the record high in the Basin of 110 degrees was registered in Goochland and Albemarle Counties. The low temperature in the Piedmont of -16 degrees was also recorded at two different stations.

In the Coastal Plain the more moderate range of temperatures reflects the influence of vast water surfaces in the general area.

In the lower reaches of the Basin the average spring date of temperatures 32 degrees or colder is March 31. In the fall this date is November 28. The corresponding dates in the mountains are May 10 and October 9. This measure shows a growing season of 240 days in the Coastal Plain compared to 150 days in the higher elevations of the Ridges and Valleys (Figure 4).

Land Resources

The total area within the hydrologic boundaries of the Basin is 6,442,400 acres1/: for the population in 1967, 5.3 acres were available to meet the needs and wants of each man, woman and child; about 92.7 percent of the Basin area was used for production of food and fiber and related needs of the people; urban and built-up areas occupied 4.6 percent; and water surfaces occupied 2.7 percent (Table II-1).

1/ Total and distribution by use and capability were compiled using hydrologic boundaries of 1967 Conservation Needs Inventory subwatersheds - varies from ERS data which was compiled using generalized county boundaries.

Table II-1. Land use distribution by subareas - 1967[1], James River Basin

Land use		Subareas I: Ridges & Valleys	Subareas II: Piedmont-Blue Ridge	Subareas III: Coastal Plain	Total	%
Agricultural						
Cropland	(1,000 acres)	142.2	439.2	154.8	736.2	11.4
	(percent)	19.3	59.7	21.0	100.0	xxx
Pasture	(1,000 acres)	254.0	377.6	24.3	655.9	10.2
	(percent)	38.7	57.6	3.7	100.0	xxx
Forest land	(1,000 acres)	1475.1	2397.7	530.7	4403.5	68.4
	(percent)	33.5	54.4	12.1	100.0	xxx
Other[2]	(1,000 acres)	35.9	84.6	54.1	174.6	2.7
	(percent)	20.6	48.5	30.9	100.0	xxx
Urban[3]	(1,000 acres)	30.3	129.4	135.6	295.3	4.6
	(percent)	10.3	43.8	45.9	100.0	xxx
Water	(1,000 acres)	7.9	50.4	118.6	176.9	2.7
	(percent)	4.5	28.5	67.0	100.0	xxx
Total	(1,000 acres)	1945.4	3478.9	1018.1	6442.4	100.0
Percent		30.0	54.0	15.0	100.0	xxx

1/ From Hydrologic Boundaries of USDA Conservation Needs Inventory Subwatersheds - includes "Non-Inventory" land and water.
2/ Farmsteads, farm roads, feed lots, marshes, etc.
3/ Cities, suburbs, highways, railroads, airports, golf courses, etc.

Land Suitability, Soils and Distribution

Tables II-2 through II-6 show various breakdowns of land use[1], capability[2] and distribution. The twelve major soil associations[3] in the Basin are delineated on Figure 6. The discussion below indicates the broad relation of the soil associations and capability classes.

Land capability classes[2] I through IV comprise 3.3 million acres or 55.4 percent of the total area currently in agriculture and forest lands (Table II-2). Lands in these classes can be safely cultivated with proper use and conservation treatment. The remaining 2.7 million acres of farm and forest lands in capability classes V through VIII are best suited for forest land, wildlife or other limited uses.

1/ For definitions of land use categories, see Appendix C, page C-1.

2/ See Appendix A, page A-1, for description of land capability classes.

3/ A soil association by broad definition, includes soils that generally derive from similar geologic formations and have similar characteristics. See Appendix A, page A-3, for technical definition and more detailed description of the soil associations shown in Figure 6.

Table II-2. Agricultural and forest land - 1967[1/], Summary - Distribution by land capability class group[2/], James River Basin

Capability Class Group	Subareas: Ridges & Valleys	Subareas: Piedmont-Blue Ridge	Subareas: Coastal Plain	Total	%
Capability Classes I-IV					
1,000 acres	370.2	2355.0	582.9	3308.1	55.4
Percent	11.2	71.2	17.6	100.0	xxx
Capability Classes V-VIII					
1,000 acres	1537.0	944.1	181.0	2662.1	44.6
Percent	57.7	35.5	6.8	100.0	xxx
Total	1907.2	3299.1	763.9	5970.2	100.0
Percent	31.9	55.3	12.8	100.0	xxx

1/ From USDA Conservation Needs Inventory Subwatersheds - includes National Forest and National Park lands.
2/ See Appendix A for description of land capability classes.

Soils in the Ridges and Valleys are formed from the weathered products of sandstone, limestone and shales. These soils lie mostly on steep, wooded slopes. Lands in capability classes VI through VIII comprise 80.6 percent of farm and forest land in this subarea (Table II-4). Soils in the higher elevations and generally on steeper slopes are in soil association 1. Association 2 is predominate in the valleys and foothills of this subarea.

Soils in the Blue Ridge are formed primarily from granite, grandiorite, greenstone and quartzite. Steep slopes and shallow soil depths are the primary factors which limit the capability of these soils and indicate the nature of soils in association 3. These soils are about equally divided in capability classes VI and VII.

Soils in the Piedmont are predominantly in associations 4 and 7 with smaller areas of associations 5, 6 and 8 and generally are described as deep to moderately deep and well drained. Parent materials include granite, gneiss, schist, sandstone, shale and greenstone. About three-fourths of these soils are in land capability classes I through IV (Table II-5).

Soils in the Coastal Plain include associations 9 through 12 which were formed from fluvial sediment from the uplands and marine deposition. The 75 percent of this subarea in capability classes I through IV are generally characterized as deep and well to moderately well drained on nearly level to gentle slopes (Table II-6). Excess water, a characteristic of soil association 12, is the primary factor which limits the capability of the remainder of these soils.

Table II-3. Distribution by use and capability - 1967[1]. Agricultural land - Total Basin, James River Basin

Land Capability[2] Class	Subclass	Cropland	Pasture	Forest land	Other[3]	Total	%
				1,000 acres			
I		42.5	21.7	7.7	3.1	75.0	1.3
II		337.3	145.6	889.2	68.0	1440.1	24.1
	e	216.6	107.1	656.1	46.7	1026.5	
	w	73.9	29.6	175.1	14.6	293.2	
	s	46.8	8.9	58.0	6.7	120.4	
III		182.1	133.7	791.0	36.3	1143.1	19.1
	e	149.0	112.0	631.0	29.4	921.4	
	w	17.0	16.9	116.6	4.2	154.7	
	s	16.1	4.8	43.3	2.7	67.0	
IV		105.3	121.3	409.2	14.0	649.8	10.9
	e	90.0	95.3	313.8	11.5	510.6	
	w	4.0	7.0	19.3	.6	30.9	
	s	11.3	19.0	76.1	1.9	108.3	
V		3.9	5.7	36.7	2.9	49.2	.8
	w	3.9	5.7	36.7	2.9	49.2	
VI		38.7	113.1	895.9	14.7	1026.4	17.8
	e	33.5	95.2	536.5	11.7	676.9	
	s	5.2	17.9	359.4	3.0	385.5	
VII		26.4	114.0	1363.3	21.4	1525.1	25.6
	e	15.1	56.1	423.4	7.5	502.1	
	w	.7	.6	25.4	6.8	33.5	
	s	10.6	57.3	904.5	7.1	989.5	
VIII		0.	.8	10.5	14.2	25.5	.4
	w	0.	0.	5.4	12.4	17.8	
	s	0.	.8	5.1	1.8	7.7	
Total		736.2	655.9	4403.5	174.6	5970.2	100.0
Total Subclass e		504.2	465.7	2560.8	106.8	3637.5	60.9
Total Subclass w		99.5	59.8	378.5	41.5	579.3	9.7
Total Subclass s		90.0	108.7	1456.5	23.2	1678.4	28.1
Total Class I		42.5	21.7	7.7	3.1	75.0	1.3

1/ From USDA Conservation Needs Inventory Subwatersheds - includes National forest lands.

2/ See Appendix A.

3/ Farmsteads, farm roads, feed lots, etc.

Table II-4. Distribution by use and capability - 1967[1]. Agricultural land - Ridges and Valleys, Subarea I, James River Basin

Land Capability[2] Class	Subclass	Cropland	Pasture	Forest land	Other[3]	Total	%
				1,000 acres			
I		9.7	6.0	0.	.2	15.9	.8
II		45.1	39.0	21.8	11.7	117.6	6.2
	e	28.5	18.1	10.8	6.2	63.6	
	w	12.2	15.4	7.1	5.4	40.1	
	s	4.4	5.5	3.9	.1	13.9	
III		32.0	37.1	41.1	6.9	117.1	6.1
	e	30.4	32.9	39.9	6.6	109.8	
	w	1.0	1.7	1.2	.1	4.0	
	s	.6	2.5	0.	.2	3.3	
IV		29.4	47.1	39.5	3.6	119.6	6.3
	e	24.6	31.1	14.9	2.2	72.8	
	w	2.2	6.0	.8	.4	9.4	
	s	2.6	10.0	23.8	1.0	37.4	
V		0.	0.	0.	0.	0.	0.
VI		15.8	42.7	473.7	4.8	537.0	28.2
	e	12.8	33.3	199.9	3.2	249.1	
	s	3.1	9.4	273.8	1.6	287.9	
VII		10.2	82.1	896.3	7.4	996.0	52.2
	e	5.0	36.6	251.0	2.6	295.2	
	s	5.2	45.5	645.3	4.8	700.8	
VIII		0.	0.	2.7	1.3	4.0	.2
	s	0.	0.	2.7	1.3	4.0	
Total		142.2	254.0	1475.1	35.9	1907.2	100.0
Total Subclass e		101.2	152.0	516.5	20.8	790.5	41.5
Total Sublcass w		15.4	23.1	9.1	5.9	53.5	2.8
Total Subclass s		15.9	72.9	949.5	9.0	1047.3	54.9
Total Class I		9.7	6.0	0.	.2	15.9	.8

1/ From USDA Conservation Needs Inventory Subwatersheds - includes National forest lands.
2/ See Appendix A.
3/ Farmsteads, farm roads, feed lots, etc.

Table II-5. Distribution by use and capability - 1967[1]. Agricultural land - Piedmont and Blue Ridge, Subarea II, James River Basin

Land Capability[2] Class	Subclass	Cropland	Pasture	Forest land	Other[3]	Total	%
				1,000 acres			
I		23.4	14.8	1.4	.3	39.9	1.2
II		181.1	93.9	633.5	40.2	948.7	28.8
	e	157.4	83.3	582.2	36.9	859.8	
	w	14.5	9.1	32.3	1.6	57.5	
	s	9.2	1.5	19.0	1.7	31.4	
III		127.2	92.3	633.7	21.6	874.8	26.5
	e	105.7	76.8	530.4	18.4	731.3	
	w	14.0	14.1	86.8	2.6	117.5	
	s	7.5	1.4	16.5	.6	26.0	
IV		68.2	72.8	342.2	8.4	491.6	14.9
	e	58.0	62.8	275.5	7.3	403.6	
	w	1.8	1.0	18.5	.2	21.5	
	s	8.4	9.0	48.2	.9	66.5	
V		3.5	3.1	30.2	.7	37.5	1.1
	w	3.5	3.1	30.2	.7	37.5	
VI		21.0	68.3	387.5	7.1	483.9	14.7
	e	18.9	59.8	301.9	5.7	386.3	
	s	2.1	8.5	85.6	1.4	97.6	
VII		14.8	31.6	366.8	5.8	419.0	12.7
	e	8.7	19.2	97.2	3.5	128.6	
	w	.7	.6	.4	0.	1.7	
	s	5.4	11.8	269.2	2.3	288.7	
VIII		0.	.8	2.4	.5	3.7	.1
	s	0.	.8	2.4	.5	3.7	
Total		439.2	377.6	2397.7	84.6	3299.1	100.0
Total Subclass e		348.7	301.9	1787.2	71.8	2509.6	76.1
Total Subclass w		34.5	27.9	168.2	5.1	235.7	7.1
Total Subclass s		32.6	33.0	440.9	7.4	513.9	15.6
Total Class I		23.4	14.8	1.4	.3	39.9	1.2

1/ From USDA Conservation Needs Inventory Subwatersheds - includes National Forest and National Park Lands.

2/ Appendix A.

3/ Farmsteads, farm roads, feed lots, etc.

Table II-6. Distribution by use and capability - 1967 1/. Agricultural land - Coastal Plain, Subarea III, James River Basin

Land Capability 2/ Class	Subclass	Cropland	Pasture	Forest land	Other 3/	Total	%
				1,000 acres			
I		9.3	.9	6.3	2.6	19.1	2.5
II		111.1	12.7	233.9	16.2	373.9	49.0
	e	30.7	5.7	63.1	3.7	103.2	
	w	47.2	5.1	135.7	7.6	195.6	
	s	33.2	1.9	35.1	4.9	75.1	
III		23.0	4.3	116.1	7.7	151.1	19.8
	e	13.0	2.3	60.6	4.3	80.2	
	w	2.0	1.1	28.6	1.5	33.2	
	s	8.0	.9	26.9	1.9	37.7	
IV		7.8	1.4	27.5	2.1	38.8	5.1
	e	7.5	1.4	23.4	2.1	34.4	
	s	.3	0.	4.1	0.	4.4	
V		.3	2.6	6.5	2.2	11.6	1.5
	w	.3	2.6	6.5	2.2	11.6	
VI		1.9	2.1	34.8	2.8	41.6	5.4
	e	1.9	2.1	34.8	2.8	41.6	
VII		1.4	.3	100.2	8.2	110.1	14.4
	e	1.4	.3	75.2	1.4	78.3	
	w	0.	0.	25.0	6.8	31.8	
VIII		0.	0.	5.4	12.3	17.7	2.3
	w	0.	0.	5.4	12.3	17.7	
Total		154.8	24.3	530.7	54.1	763.9	100.0
Total Subclass e		54.5	11.8	257.1	14.3	337.7	44.2
Total Subclass w		49.5	8.8	201.2	30.4	289.9	38.0
Total Subclass s		41.5	2.8	66.1	6.8	117.2	15.2
Total Class I		9.3	.9	6.3	2.6	19.1	2.5

1/ From USDA Conservation Needs Inventory Subwatersheds - includes National Park Lands.
2/ See Appendix A.
3/ Farmsteads, farm roads, feed lots, marshes, etc.

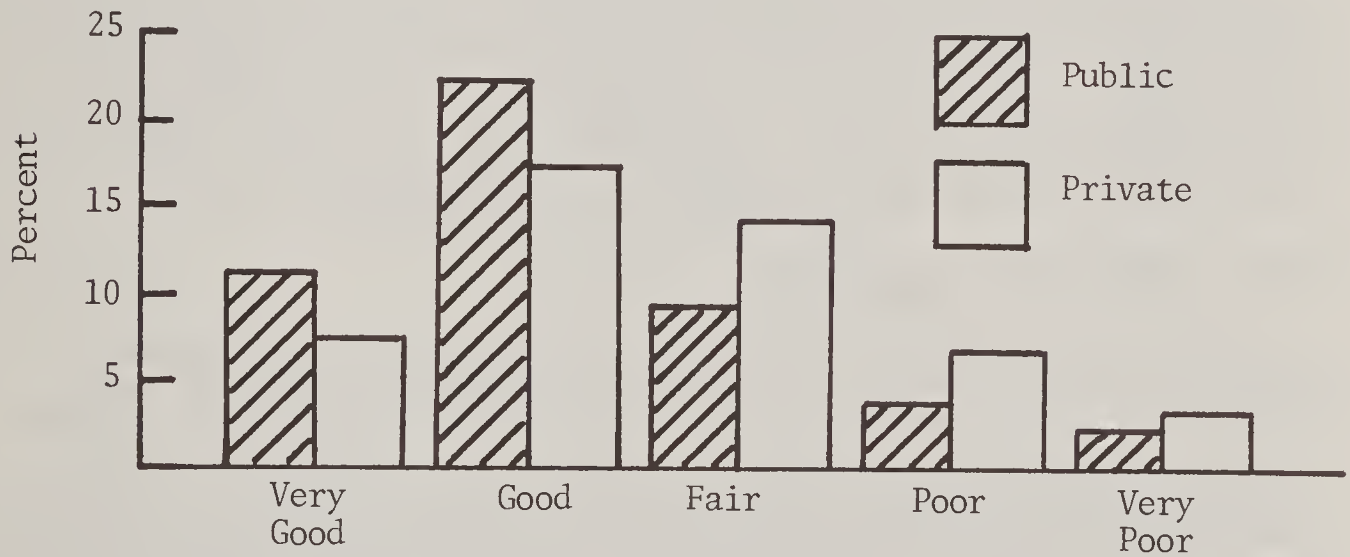
Land Use and Vegetation

Forest land occupies 4.4 million acres or about 74 percent of the agricultural land and will maintain about that same portion of land use for the foreseeable future. As the major source and primary filtering agent of the water supply for the Basin, maintenance of good vegetative cover on these forest lands is of vital importance.

Graph 1 indicates that 80 percent of these forest lands are in fair to very good hydrologic condition. Virginia forest surveys show that growing stock continues to increase, generally improving the hydrologic condition of the forest land.

Pasture occupies 655,900 acres or about 11 percent of the land (Table II-1). The combined acreage of forest and pasture provide relatively good vegetative cover conditions on about 81 percent of the land throughout the Basin. Cropland occupies 736,200 acres or about 12 percent of the land. Sheet and gully erosion is the dominant conservation hazard on 68.5 percent of this acreage. Farmsteads, urban areas, highways, and other miscellaneous uses occupy 469,900 acres or about 7 percent of the land area. Impervious surfaces in urban areas add to flood runoff.

Graph 1. Present hydrologic condition of forest soils 1/, James River Basin



1/ Based on 1,614 samples in 32 subwatersheds containing 2,077,000 acres (32.3 percent of James River Basin), 783,000 acres in Piedmont, 220,000 acres in Blue Ridge, and 1,074,000 acres in Ridges and Valleys. This data was collected prior to the storm of Hurricane Camille (August 1969), which did extensive damage to forest lands in Nelson, Amherst, Albemarle, and Rockbridge Counties.

Management

About 83 percent of the Basin is privately owned. Various Federal and State agencies manage about 17 percent of the land. Most of these holdings are in the George Washington and Jefferson National Forests and are administered by the U.S. Forest Service. These forests are located in the higher elevations of the Ridges and Valleys. The Blue Ridge Parkway, managed by the National Park Service, lies along the crest of the Blue Ridge. Several smaller national parks and military reservations are located primarily in the Coastal Plain.

Several agencies of the State of Virginia have jurisdiction over scattered holdings in the Basin. The largest portion is in road and highway rights-of-way. About 110,000 acres are in game management areas, State forests and recreation parks.

Water Resources

The following brief discussion provides only a broad assessment of availability, use, and management of water resources as a basis for consideration of upstream needs for development. Other volumes of the comprehensive report will provide more detailed data and discussion on consumptive use for municipal and industrial needs.

The average surface water yield of the Basin would provide over 2,000 gallons per capita per day for the projected population in the year 2020. Substantial amounts of ground water are also available in the Basin. Generally, the natural quality of both surface and ground water supplies is good to excellent. With efficient use and application of measures to maintain quality, the water resources of the Basin are more than adequate to meet foreseeable needs.

Yield, Distribution and Quality

The water resources of the Basin derive from a normal annual precipitation of 43 inches. Average annual surface runoff is about 15 inches. Table II-7 provides an indication of the distribution and yield available at various points in the Basin. Efficient use will require adequate storage to carry through drought periods. In the drought year of 1930, the average runoff was less than one-half of the normal and in some areas was as little as three inches. In the wet year of 1937, average runoff was about 21 inches and some stations recorded double their average annual flow. Seasonally, 75 percent of the runoff usually occurs in the six months period from December through May, but less than half of the annual precipitation falls during this period.

Generally the natural quality of surface water is such that only minimum treatment and costs are required for most uses. High intensity rainfall causes temporary excessive sedimentation and turbidity. With continued improvement in land use and conservation

Table II-7. Average surface water yield at selected stations (Millions of gallons per day), James River Basin

Stream	Location	MGD
	Subarea I - Ridges and Valleys	
Back Creek	Near Mt. Grove	100
Jackson River	Falling Springs	300
Dunlap Creek	Near Covington	100
Potts Creek	Near Covington	110
Bullpasture River	Williamsville	80
Cowpasture River	Near Clifton Forge	330
Johns Creek	Near Newcastle	80
Craig Creek	Parr	240
Calfpasture River	Goshen	100
James River	Lick Run	1000
Maury River	Rockbridge-Bath	230
Maury River	Buena Vista	400
	Subarea II - Piedmont-Blue Ridge	
Piney River	Piney River	50
Tye River	Near Lovingston	90
Buffalo River	Near Norwood	90
Rockfish River	Near Greenfield	80
Hardware River	Near Scottsville	70
Moorman River	Near Whitehall	10
South Fork Rivanna River	Near Earlysville	130
Rivanna River	Palmyra	430
Appomattox River	Farmville	180
Appomattox River	Mattoax	460
James River	Holcomb Rock	2240
James River	Scottsville	3200
	Subarea III - Coastal Plain	
James River	Richmond	4650
Chickahominy River	Near Providence Forge	170

Source: U. S. Geological Survey.

treatment, the quality and quantity of this raw water supply will be adequate for projected needs. A few springs and seeps contribute highly mineralized and acidic water to stream flow, but the effects are not significant except in the immediate area.

Ground water potential is highly variable throughout the Basin. Only in the Coastal Plain is there any dependable pattern in the occurrence of large quantities of ground water. Figure 2 relates the general distribution and indicates the ground water potential in the Basin.

In the Coastal Plain, yields of over 300 gallons per minute have been produced from deep wells which tap high-yielding aquifers. High water table conditions exist in large portions of the area. Numerous shallow wells and "dug ponds" drawing on these supplies afford convenient sources of water for rural domestic and livestock uses.

Ground water in the Coastal Plain ranges from soft to hard, but generally is of suitable quality for domestic and industrial use. Salt water encroachment is a problem where pumping rates exceed the recharge rate.

In the Piedmont, the ground water yield is relatively low because of the predominance of impervious rock. The average well yields less than 15 gallons per minute. Most of the ground water is confined to fractures and other openings in rocks within a few hundred feet of the surface. A few wells produce 50 to 100 gallons per minute and many wells are adequate for farm and rural domestic use.

In the Blue Ridge area few communities depend on wells as a main supply source. Carefully selected well sites may yield up to 300 gallons per minute. Generally, jointing and fault openings of rocks in this area offer less resistance to the passage of water than other formations. Ground water usually is low in mineral content because of the insolubility of the rocks and the short duration of contact with the rocks.

In the Ridges and Valleys occasional cavernous formations in limestone furnish some of the largest yields per unit of well field area. Some areas yield sustained withdrawals of over 500 gallons per minute.

The remainder of the Ridges and Valleys is underlain mostly by insoluble rocks. Moderate amounts of ground water have been found in the faults, folds, fractures, and bedding planes of these formations but yields are generally less than 20 gallons per minute.

Ground water in the Ridges and Valleys is generally of suitable quality for public use. Water from some calcareous rocks is hard to very hard. Some shales produce water high in iron content. Several highly mineralized warm water springs attract many visitors to the area.

Use and Management

Table II-8 shows water withdrawals for public systems and large industrial users in 1966. This provides an indication of the use-distribution in the three evaluation subareas as shown in Table II-9.

Table II-8. Water withdrawals - by subarea[1/] - 1966, James River Basin

Subarea	Ground	Surface	Total
	Million gallons per day		
Ridges and Valleys	6.1	80.3	86.4
Piedmont - Blue Ridge	6.0	73.9	79.9
Coastal Plain	15.3	492.4	507.7
Totals	27.4	646.6	674.0

Table II-9. Comparison - Water withdrawals, Population and area, 1966, James River Basin

Subarea	Water[1/] Withdrawals	Population	Area
		% of Basin total	
Ridges and Valleys	13	10	30
Piedmont - Blue Ridge	12	28	48
Coastal Plain	75	62	22
Totals	100	100	100

1/ Source: Virginia Division of Water Resources (excludes 1500 mgd for irrigation and thermal electric cooling).

Table II-9 indicates that the Coastal Plain subarea, with 22 percent of the Basin area and 62 percent of the population, uses 75 percent of the water. Figures for the Piedmont-Blue Ridge subarea reflect lower population density and less industrial development. In that subarea, 28 percent of the population makes 12 percent of the water withdrawals. The 10 percent of the Basin population in the Ridges and Valleys accounts for 13 percent of the water used. The pulp and paper plant at Covington uses over 50 percent of the water withdrawals in the Ridges and Valleys subarea.

Most farmsteads obtain water for domestic and livestock needs from individually developed wells and springs. Towns and rural residential communities depend primarily on wells for small central supply systems. A growing number of rural communities are developing small surface storage impoundments.

Fish and Wildlife Resources

Water areas comprise about 176,900 acres or 2.7 percent of the Basin. About two-thirds of these waters are in the estuary and tidal tributaries of the James River. Freshwater ponds, reservoirs, and streams east of the Blue Ridge account for 29 percent of the fishing waters. About 4 percent of the fish habitat is in the Ridges and Valleys.

The total annual harvest of all fish is about 17.7 million pounds[1/]. Ninety-seven percent are taken from the lower James and its tributaries; 2.5 percent from the freshwaters east of the Blue Ridge; and only five-tenths of one percent from the Ridges and Valleys subarea.

Some of the finest seed oysters in the world are produced in beds near the mouth of the James River. Soft-shell crabs and a large variety of finfish are also harvested in this general area.

Predominant freshwater species are bass, catfish, and various sunfish. Several publicly owned lakes are stocked and managed by agencies of the State of Virginia. Fishing quality in 6,280 farm ponds (1967) varies from poor to excellent dependent upon management and other purposes for which they are used.

About 460 miles of marginal and extremely marginal trout waters are found in the Blue Ridge and the Ridges and Valleys. Short reaches of the upper Cowpasture and Jackson Rivers support native trout, but practically none of the other streams provide the critical conditions throughout the year which are necessary for natural reproduction. Low flows and warm temperatures also limit the season for the stocking of hatchery trout to late spring and early summer in most of the streams.

An estimated two million acres in the Basin are managed in varying degrees and intensity for wildlife and hunting. About 40 percent of these lands are in the George Washington and Jefferson National Forests. The State of Virginia has purchased nine public hunting areas totaling 78,346 acres and manage wildlife resources on another 30,000 acres in State forest, parks, and

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1/ Fish and Wildlife Resources - Chesapeake Bay and Tributaries, U. S. Department of Interior, Bureau of Sport Fisheries and Wildlife, 1968.

recreation areas. Numerous wood using industries have opened large tracts of land to public hunting either through cooperative agreements or through annual permits to individuals. Hunt clubs and similar groups have acquired hunting rights by purchase, lease, or cooperative agreements on numerous private holdings. Wildlife food planting projects are carried out on innumerable individual farms.

The James River Basin comprises approximately 25 percent of the total area of the State, and in 1967-1968 produced 40 percent of the deer, 52 percent of the black bears, and 53 percent of the wild turkeys taken in Virginia.

The Ridges and Valleys produces a major portion of the deer, bear, and turkey harvest (Table II-10). This mountainous wooded area supports a low percentage of the small game except for squirrels.

Table II-10. Big game harvest, 1967-1968, James River Basin

Subarea	Deer		Bear		Turkey	
	Number	Percent	Number	Percent	Number	Percent
Ridges and Valleys	6,750	59	130	71	850	67
Piedmont-Blue Ridge	2,916	26	53	29	397	31
Coastal Plain	1,708	15	0	0	16	2
Basin Totals	11,374	100	183	100	1,263	100

Source: Virginia Commission of Game & Inland Fisheries.

The Piedmont-Blue Ridge area yields a moderate portion of the deer, bear, and turkey, but the area is generally better adapted to small game such as quail, doves, and rabbits.

The Coastal Plain still supports moderate harvests of deer in spite of intensive urban and industrial development. The large expanses of wooded flatlands also provide habitat for squirrels and other small game.

A 1956 study1/ lists 14,000 acres of high value waterfowl habitat and about 55,000 acres of lower value wetlands in the Basin. Except for about 11,000 acres of low value habitat along the main stem of the James and Appomattox in the lower Piedmont, these wetlands lie in the Coastal Plain subarea. A 2,435 acre preserve

1/ Wetlands of the United States, 1956, F&WS Circular 39.

has been developed by the Virginia Commission of Game and Inland Fisheries at Hog Island in Surry County. At the height of the migrating season the duck and goose population has been estimated at up to 50,000. Migrating and native waterfowl are attracted to other marshes, swamps, and tidal streams in the Coastal Plain.

Recreation Resources

The inventory of outdoor recreation resources for the James River Basin was tabulated for each of four subareas (Figure 12) and separated as either existing or potential recreation supply[1/]. Recreation supply was further divided by area classes and by its dependence on the presence of water in order to establish surpluses or deficits. The recreation inventory includes Federal, State, local, and private recreation supply.

Existing Recreation Supply

Projections of 1965 capacities in annual recreation days for the various land classes and by water dependency levels are summarized in Table II-11. The capacity of total existing recreation supply is estimated to exceed 53.6 million recreation days annually of which 36.2 million or about 67 percent is found in the Norfolk subarea. This capacity reflects both recreation opportunity on class I and IV lands in a subarea with high density population needs and with abundant cultural and historical sites. A similar situation exists in the Richmond subarea, but on a diminished scale. It should be noted that although the Norfolk and Richmond subareas provide most of the recreation opportunities, they are doing so on considerable fewer acres than identified in the Appalachia and Appomattox subareas, where most supply is class II or low density use lands.

1/ The recreation inventory and analysis presented in this report was done by the Bureau of Outdoor Recreation in Atlanta. Their methodology and data are presented in two preliminary reports which were available for our use. A final report from the BOR is forthcoming and will also become an appendix to the Corps of Engineers final Summary Report. Therefore, recreation data and conclusions used for this report are subject to change in the final BOR report. The preliminary reports used for this report are:

1) Present Use, Projected Use, Planning Goals: Outdoor Recreation Interium Report Number 1: James River Basin, Review Draft, December, 1969.

2) Outdoor Recreation Report, James River Basin Comprehensive Study, Virginia, Review Draft, May, 1972.

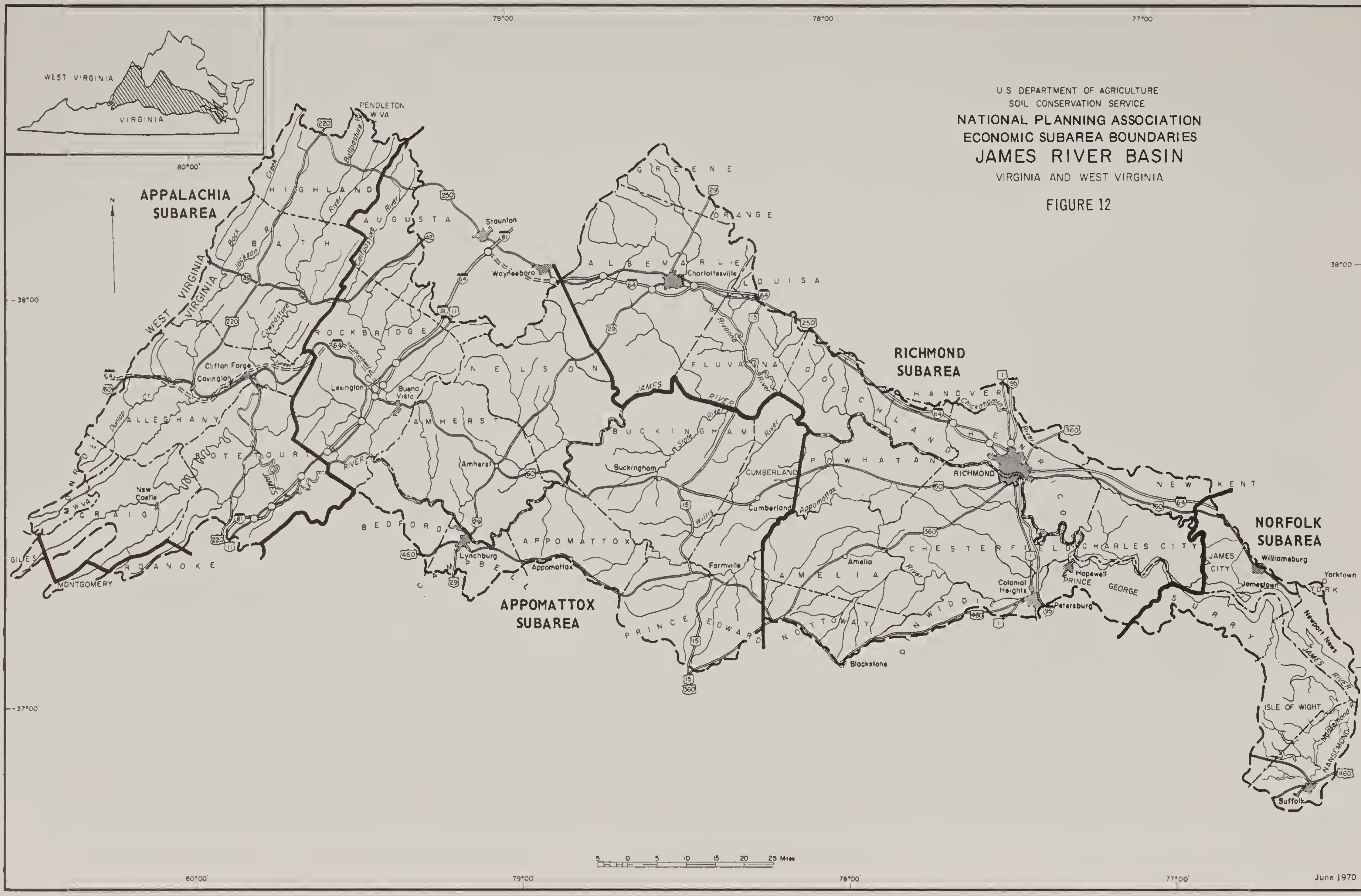
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NATIONAL PLANNING ASSOCIATION
ECONOMIC SUBAREA BOUNDARIES
JAMES RIVER BASIN
VIRGINIA AND WEST VIRGINIA
APPALACHIA SUBAREA
RICHMOND SUBAREA
NORFOLK SUBAREA
APPOMATTOX SUBAREA
WEST VIRGINIA
VIRGINIA
HIGHLAND
BATH
AUGUSTA
ALLEGHANY
ROCKBRIDGE
BOTETOURT
CRAIG
ROANOKE
MONTGOMERY
GILES
GREENE
ORANGE
ALBEMARLE
LOUISA
NELSON
AMHERST
BEDFORD
CAMPBELL
APPOMATTOX
BUCKINGHAM
FLUVANNA
GOOCHLAND
HANOVER
HENRICO
POWHATAN
CUMBERLAND
PRINCE EDWARD
NOTTOWAY
AMELIA
CHESTERFIELD
DINWIDDIE
PRINCE GEORGE
CHARLES CITY
NEW KENT
JAMES CITY
YORK
SURRY
ISLE OF WIGHT
NANSEMOND
PENDLETON W VA
Staunton
Waynesboro
Charlottesville
Clifton Forge
Covington
Lexington
Buena Vista
New Castle
Amherst
Lynchburg
Appomattox
Buckingham
Cumberland
Farmville
Amelia
Blackstone
Richmond
Colonial Heights
Petersburg
Hopewell
Williamsburg
Jamestown
Yorktown
Newport News
Suffolk
James River
Rivanna River
Slate River
Willis River
Appomattox River
Chickahominy River
Cowpasture River
Bullpasture River
Calfpasture River
Jackson River
Back Creek
Dunlap Cr.
Nansemond R.
80°00'
79°00'
78°00'
77°00'
38°00'
37°00'
5 0 5 10 15 20 25 Miles
June 1970
USDA-SCS-HYATTSVILLE, MD. 1970

FIGURE 12

Table II-11. Summary, total[1] annual outdoor recreation day capacity of existing (1965) recreation supply by subarea and water dependency level, James River Basin, Virginia

Subarea	Acres (1,000)	Annual Recreation Day Capacity (1,000)			
		WD[2]	WE[3]	NW[4]	Total
Appalachia	572.8	220.4	2,882.2	63.0	3,165.6
Appomattox	228.2	422.5	1,508.8	547.3	2,481.6
Richmond	55.3	523.0	1,527.0	9,765.5	11,815.5
Norfolk	72.1	499.0	29,077.8	6,635.9	36,212.7
James River Basin	928.4	1,156.9	33,206.8	17,011.7	53,675.4

Source: 1969 Preliminary Outdoor Recreation Report.
1/ Includes both public and private recreation supply.
2/ Water dependent recreation activities.
3/ Water enhanced recreation activities.
4/ Recreation activities not dependent or enhanced by water.

Existing recreation development within the Basin includes a full range of facilities on public, quasi-public, and private lands. All cities have recreation facilities from school recreation sites to fairly sizable tracts specifically designated for public recreation. The State administers areas throughout the Basin for fishing, hunting, public water access, natural area preservation, and for a diversified range of recreation activities for both day and overnight use. The Federal Government also administers major land holdings for varying recreation opportunities. These areas range from those managed primarily to provide habitat and protection for migratory waterfowl to areas providing general recreation opportunity including those of historic, natural, or scenic values. Innumerable private and quasi-public recreation developments include resorts, camps, hunting preserves, etc. In recent years, the forest industry has opened its lands to the public for recreation purposes. In addition, hydroelectric power companies provided recreation opportunities at licensed projects within the Basin.

Of the total outdoor recreation supply, public (Federal, State, and local) areas totaled approximately 850,000 acres which has an estimated capacity of 44.3 million recreation days annually (Table II-12).

An examination of Table II-12 reveals the differences in development found in the four subareas. For example, most designated outdoor recreation acreage, about 65 percent, is found in the Appalachia subarea, while it has only a little more than 5 percent of the estimated total capacity in terms of development. Conversely, the Norfolk subarea contains an estimated 7 percent of the total

Table II-12. Summary, total annual outdoor recreation day capacity of existing (1965) public recreation supply by subarea and water dependency level, James River Basin, Virginia

Subarea	Acres	Annual Recreation Day Capacity (1,000)			
		WD[1]	WE[2]	NW[3]	Total
Appalachia	549,485	114.0	2,330.7	22.9	2,467.6
Appomattox	213,964	254.4	995.8	369.3	1,619.5
Richmond	22,435	337.3	444.7	5,834.9	6,616.9
Norfolk	63,642	192.8	27,893.8	5,514.9	33,601.5
James River Basin	849,526	898.5	31,665.0	11,742.0	44,305.5

Source: 1969 Preliminary Outdoor Recreation Report.
1/ Water dependent recreation activities.
2/ Water enhanced recreation activities.
3/ Recreation activities not dependent or enhanced by water.

recreation acreage yet accounts for better than 75 percent of the total capacity.

Further examination shows that the capacity for water related activities in the Appalachia and Appomattox subareas is associated with class III lands or large areas managed for multiple purposes including recreation. Water related recreation capacities in the Richmond and Norfolk subareas are primarily associated with class IV lands or areas specifically dedicated for cultural purposes.

A comparison of the distribution of acreages by class is revealing in that it shows the relative importance of these areas in satisfying recreation demand for the various subareas. Type I lands or high impact areas are generally absent from the Appalachia and Appomattox subareas, while in the Richmond and Norfolk subareas this type of land use predominates, being necessary to satisfy the day use needs within an urban environment.

The recreation capability of the Basin's water and associated land for meeting recreation demand is discussed in the following paragraphs. In their present state, the Basin's streams and lakes have a capacity of approximately 2.3 million recreation days annually (Table II-13). In addition, the effectiveness of existing public and private recreation supply is discussed.

Streams and Rivers. In total the James River drainage system contains approximately 2,500 miles of streams and rivers which comprise about 87,000 surface acres of water (Table II-14).

Table II-13. Annual outdoor recreation day capacity of existing (1965) incidental recreation supply by subarea, area class, and water dependency level[1/], James River Basin, Virginia

Subarea and Area Class	Annual Recreation Capacity (1,000's) Water Dependent	Water Enhanced	Total
Appalachia			
I	-	-	-
II	10	24	34
III	42	163	205
Subtotal	52	187	239
Appomattox			
I	-	-	-
II	49	176	225
III	58	202	260
Subtotal	107	378	485
Richmond			
I	23	70	93
II	83	334	417
III	59	182	241
Subtotal	165	586	751
Norfolk			
I	16	114	130
II	85	377	462
III	83	150	233
Subtotal	184	641	825
James River Basin			
I	39	184	223
II	227	911	1,138
III	242	697	939
Total	508	1,792	2,300

Source: 1972 Preliminary Outdoor Recreation Report.

1/ Represents existing recreation capacity of the Basin's water and associated land resources. Includes lakes and impoundments and streams not identified with other agencies or as private supply.

In order to estimate a stream's recreation capability, the James River and its major tributaries were classified according to the following classes:

Class A - Streams with mainly visual appeal and with limited recreation opportunity (too small to use for boating or canoeing).

Class B - Rivers and streams with canoeing and general recreation potential.

Class C - Rivers of sufficient depth and width to use for boating and general recreation.

Table II-14. Streams and rivers classification and degree of pollution, James River Basin, Virginia

	Streams and Rivers Size Classification A	B	C	Total
Total Miles	800	1,050	650	2,500
Total Acres	1,000	4,800	82,000	87,800
Acres Per Mile	1.25	4.57	126.15	-
Total Miles Polluted	13	223	412	648
Percent of Total	1.6	21.2	63.4	-
Total Acres Polluted	15	2,516	72,878	75,409
Percent of Total	1.5	52.4	88.9	-

Source: 1972 BOR Recreation Report for the James River Basin.

Using the above classifications, the rivers and streams of the James River Basin were tabulated as shown in Table II-14. Most streams within the Basin fall within category "B", as represented by the Jackson, Rivanna, Slate Rivers, etc., located primarily in the Valley and Ridge and Piedmont sections. These streams are relatively small when compared to class "C" streams such as the James and Appomattox Rivers which are located in the Piedmont and Coastal Plain provinces. Because of the lack of use data for streams in the above categories, recreation use by class was judged to be at least equal to annual fishermen days of use. Based on this assumption, the average fishermen days per mile by class of stream was utilized to establish present capacities or utilization (Table II-15).

In general, streams have been particularly vulnerable to the works of man resulting in a loss of substantial recreation potential. Limited public access has further reduced water based recreation opportunities in the Basin. Except for development at Richmond and Lynchburg, there has been few riverside parks or other river oriented developments. Many streams including the James River have been blocked off by railroads or private land holdings, thus preventing its full utilization for recreation.

Table II-15. Existing annual outdoor recreation capacities of streams and rivers[1/], James River Basin, Virginia

Class	Estimated Miles	Annual Recreation Days/Mile	Total Annual Recreation Days
A	800	112	89,600
B	1,050	224	235,200
C	650	2,371	1,541,150
Total Existing Capacity			1,865,950

Source: 1972 BOR Report for James River Basin.
1/ Based on preliminary fish and wildlife estimates of 16 potential reservoir projects within the James River Basin. Bureau of Sport Fisheries and Wildlife, January 1970.

Lakes and Impoundments. Surface water area in the Basin totals about 137,419 acres of which approximately 49,619 acres or 36 percent is attributable to natural lakes and impoundments (Table II-16). Categorically, lakes larger than 200 acres provide the bulk of total Basin surface area with 41,359 acres. Included in the total is the 20,000 acre Smith Mountain Reservoir and its companion 3,500 acre Leesville reregulating reservoir constructed by the Appalachian Power Company. These two reservoirs are included because of their accessibility to the population center of Lynchburg which is located within the Basin.

Other reservoirs include Federal Power Commission licensed projects on the James River, privately owned industrial and recreation impoundments, as well as numerous municipal water supply impoundments scattered throughout the Basin. In the latter group, several significant reservoirs have been constructed or expanded in recent years (Table II-17). In most instances, the full potential of these reservoirs has not been realized.

Through its Division of Parks and Commission of Game and Inland Fisheries, the State operates a number of lakes and impoundments for public purposes.

The present utilization of lakes and impoundments is considered to be low, with less than a million annual recreation days for an estimated 49,619 acres of water. Estimates of use as presented in Table II-18 are based on actual visitation per acre per year times total water surface acreage for each respective size class.

Table II-16. Useable water surface acre existing lakes and impoundments, 1965, James River Basin, Virginia

	Subarea					
	Appalachia	Appomattox	Richmond	Norfolk	Total	Average Size
			Acres			
Number of Lakes						
Size	5	20	59	36	120	
(-)40	64	385	961	709	2,119	17.1
Number of Lakes						
Size	1	14	23	26	64	
40-200	60	1,575	1,822	2,684	6,141	96.0
Number of Lakes						
Size	1	6	3	13	23	
(+)200	630	26,035 1/	4,550	10,144	41,359	1,798
Total Water Area	754	27,995	7,333	13,537	49,619	

Source: 1972 BOR Report for James River Basin, Virginia.

1/ Leesville Reservoir in Campbell County comprises 3,400 acres of total and Smith Mountain Reservoir in Bedford County comprises 20,000 acres of total.

Public Administered Recreation Land and Facilities. Within the James River Basin is a varied pattern of public administered recreation lands reflecting both intensive and extensive development which offer a diversity of recreation opportunity. This composition is shown by subarea in Table II-19. Exclusive of military lands which total 197,011 acres, public recreation land in 1970 totaled an estimated 824,245 acres.

Distribution of public lands range from a high of 713,169 acres in the Appalachia subarea to a low of 23,238 acres in the Richmond subarea. Public recreation land in the Norfolk subarea, less those lands occupied for military purposes, totaled 30,364 acres.

The most intensively developed public lands, aside from those found at the local level of government or on the class I level, are the Basin's State parks. During the 1960's park attendance statewide has been growing at an average rate of 14 percent per year or a doubling amount about every seven years. Almost half or 49 percent of the total park attendance between 1960 and 1968 took place at Seashore State Park which accounts for more than one-fourth of the total attendance at all State parks, indicating

Table II-17. Major water supply reservoirs in excess of 200 acres, James River Basin, Virginia

Reservoir Name	Subarea	Location	Acreage
Dlascord	3	New Kent County	1,200
Carvin Cove	1	Botetourt County	630
Chickahominy	3	Charles City County	1,500
Harwoods Mill Pond	4	York County	300
Lake Burut Mills	4	Isle of Wight County	600
Lake Chesdin	3	Chesterfield County	3,600
Lake Cohoon	4	Nansemond County	737
Lake Kilby	4	Nansemond County	226
Lake Meade	4	Nansemond County	786
Lake Prince	4	Nansemond County	900
Lake Smith	4	Virginia Beach	222
Lee Hall	4	Newport News	400
Little Creek	4	Virginia Beach	709
South Rivanna	3	Albemarle County	390
Swift Creek	3	Chesterfield County	1,700
Western Brance	4	Nansemond County	1,600
Total			15,500

Source: 1972 BOR Report for James River Basin, Virginia.

Table II-18. Existing annual outdoor recreation day capacity of lakes and impoundments - 1965, James River Basin, Virginia

Subarea	Total Water Area			Total Annual
	(-)40 1/	40-200 2/	(+)200 3/	Recreation Days
Appalachia	320	660	13,860	14,840
Appomattox	1,925	17,325	572,770	592,020
Richmond	4,805	20,042	100,100	124,947
Norfolk	3,545	29,524	223,168	256,237
Total	10,595	67,551	909,898	988,044

Source: 1972 Preliminary Outdoor Recreation Report.
1/ Based on five annual recreation days per acre per year.
2/ Based on 11 annual recreation days per acre per year.
3/ Based on 22 annual recreation days per acre per year.

Table II-19. Distribution of public administered recreation lands and waters, James River Basin

Subarea	Name	No. of Units	Acreage Total	Acreage Water
Appalachia	U. S. Forest Service[1/]	2	672,000	501
	National Park Service[2/]	2	N/A	N/A
	National Fish Hatchery	2	498	(Spring)
	State Parks	1	4,493	70
	State Wildlife Management Areas	2	36,145	(Rivers)
	Waysides	1	6	(Rivers)
	Local Public Areas	-	27	-
	Total	10	713,169	571
Appomattox	National Park Service	1	933	4
	Military Installations	1	41	-
	State Parks	1	130	37
	State Recreation Areas	3	540	200
	State Natural Areas	1	900	-
	State Forests	3	32,500	44
	State Wildlife Management Areas	3	22,025	(Rivers)
	Public Fishing Lake	1	60	4
	Public Access Areas	5	N/A	(James Ri)
	Waysides	3	147	7
	Local Public Areas	-	459	-
	Total	22	57,755	296
Richmond	National Park Service	3	3,182	4
	National Fish Hatchery	1	254	190
	National Wildlife Refuge	1	1,329	(James Ri)
	Military Installations	1	190	90
	State Parks	1	2,005	181
	Battlefield Park	1	215	-
	State Forest	3	5,600	-
	State Wildlife Management Areas	3	6,834	420
	Public Fishing Lakes	2	140	120
	Public Access Areas	8	N/A	(James & Rivanna Ris)
	Local Public Areas	-	3,489	-
	Total	24	23,238	1,005
Norfolk	National Wildlife Refuges	2	5,431	-
	Military Installations	15	196,780	2,081
	State Parks[3/]	3	4,477	-
	State Natural Areas[4/]	2	19	20
	State Wildlife Management Areas	2	3,628	825
	Public Access Areas	7	N/A	-
	Local Public Areas	-	16,809	-
	Total	31	227,144	2,926

Source: 1972 Preliminary Outdoor Recreation Report.

1/ Includes U.S. Forest Service lands in both the Appalachian and Appomattox subareas.
2/ Includes the Appalachian Trail and the Blue Ridge Parkway.
3/ Includes area administered by the Jamestown Foundation.
4/ 100 acres contained within State Park.

the tremendous demand for seashore oriented recreation. Other State park attendance has increased dramatically during the 1960-1968 period to average from 6 to 34 percent per year.

In most instances, State park attendance growth would not serve as an indication of demand since visitation is restricted by limitations in park size and/or adequate facility development. In the case of Seashore State Park, campers turned away in 1969 amounted to 46 percent of capacity. This situation also prevails at Douthat State Park but to a lesser degree. In contrast, there are several parks or recreation areas within the Basin such as Holiday Lake, Goodwyn Lake, Bear Creek Lake, and Prince Edward State Park that can handle heavy peaks because of their ample installed capacity.

Private Recreation Enterprise. The contribution that privately operated businesses can make in meeting the future outdoor recreation needs could be more than it is now. Many factors tend to dissuade the full potential of private enterprise. One of these factors stems from the lack of financial assistance programs which would help individuals in starting new businesses and improving existing operations. The high premium for personal liability insurance makes this type of protection almost prohibitive for certain types of recreation endeavors. The problems and setbacks encountered by private operators of commercial recreation facilities are often complex and not easily solved, thus discouraging potential recreation development.

Appalachian Program

Five counties in the western part of the James River Basin fall within Subregion C of the Appalachian Region[1/]. The counties are Highland, Bath, Alleghany, Craig, and Botetourt.

Subregion C contains some of Virginia's most charming and scenic countryside, much sought after as recreation area. The interstate highways will bring many thousands of visitors from the metropolitan eastern seaboard. Though much of the land is in public ownership (George Washington and Jefferson National Forest and Blue Ridge Parkway), additional water based recreation opportunities are necessary to meet the growing population and increasing flow of visitors.

The U.S. Army Corps of Engineers, Norfolk District, is presently constructing Gathright Dam and Reservoir. This project is the only major Federal authorized reservoir in the subregion. The Gathright damsite is located on the Jackson River about 19 miles upstream

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1/ Development of Water Resources in Appalachia, Main Report, Part II, Sub-Regional Plans A, B, C, Office of Appalachian Studies, Corps of Engineers, Department of the Army, P.O. Box 1159, Cincinnati, Ohio, November, 1969.

from Covington. The project, scheduled to become operational in 1973, is designed to provide for flood control, water quality control, and recreational development.

At Gathright Reservoir, suitable access to the water and recreation facilities will be provided. The Gathright Project will provide an excellent and much needed facility for water based recreation. There are no other major reservoir projects in Subregion C or within a 50 mile radius of Gathright. Three existing Corps of Engineers' reservoirs, Bluestone, Sutton, and Summerville are located in West Virginia, just outside the 50 mile radius. Two new reservoirs, Smith Mountain and Leesville have recently been completed by the Appalachian Power Company on the Roanoke River outside of Subregion C.

CHAPTER III

ECONOMIC DEVELOPMENT

This chapter presents economic information required for assessing the present and projected demands of the Basin and for planning of upstream resource development to meet these needs. Projections of appropriate data were made for the years 1980, 2000, and 2020.

The data was generalized by counties for the three subareas described in Chapter II and shown in Figure 7. The Blue Ridge and Piedmont physiographic provinces were combined along generalized county boundaries and designated as Subarea 2 or Cluster II. The Ridges and Valleys province generally corresponds to Subarea 1 or Cluster I, and the Coastal Plain province to Subarea 3 or Cluster III.[1/]

Historical Development

The economy of the Basin was based almost entirely on agriculture for about 100 years following the first settlement at Jamestown in 1607. Export of agricultural products, particularly tobacco, provided practically the only source of outside income.

Few of the early colonists strayed beyond the upper reaches of the navigible tidewaters near the present city of Richmond. Of necessity and convenience, they cleared fields out of the seemingly limitless forests along the estuary of "King James River". The forest furnished wood for shelter and the level fields of fertile soil provided food and clothing. Abundant wildlife and fish provided a varied diet. Large plantations became largely self-sufficient communities and handicrafts provided tools, furniture, glassware, pottery, leather goods, and similar needs.

Shipping and related commercial enterprises began their gradual but steady growth along the lower estuary. Other industries had similar beginnings primarily in the Richmond and Petersburg areas where the sharp rise in stream gradients allowed greater utilization of water power. Today more than half of the population and commercial activity is concentrated in this lower one-fourth of the Basin, although about 80 percent of the area is still devoted to farms, forest, marsh, wooded swamps, and open water.

1/ Different subarea delineations were used for discussions of recreation in this report.

The first settlers of the rolling foothills of the Piedmont also found an abundance of forests and land. When the topsoil eroded from one of the sloping fields, another area of forest land was cleared for cultivated crops. With few exceptions, such wasteful practices prevailed well into the 1900's. Eventually the steady erosion of the soil base of the area could no longer be denied. Shifts from row-crop farming to livestock, better management of forest lands, and general improvements in conservation management are contributing toward stabilization of what is still the major agricultural area of the Basin.

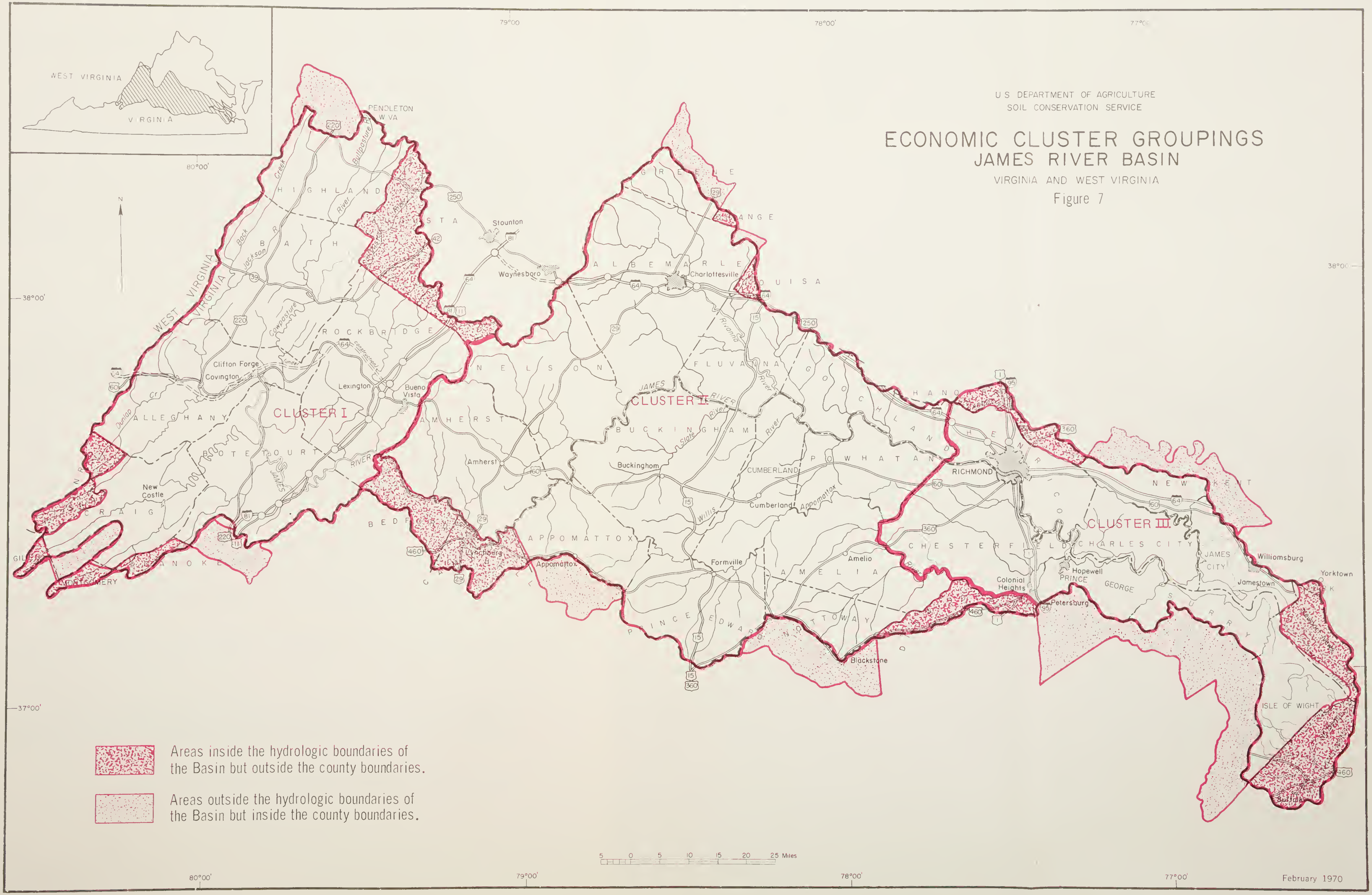
Even today much of the industry and commerce of the Piedmont is based on agriculture. In recent years, small manufacturing plants in the numerous town and crossroad communities and growth of other businesses have absorbed a portion of the rural labor force no longer needed on farms. The city of Lynchburg is centrally located on the James River and has long been the principle population and commercial center of the Piedmont.

Only the hardiest pioneers ventured beyond the Blue Ridge Mountains to settle in the narrow upland valleys to the west. This is still the most sparsely populated area of the Basin. The large areas of steep wooded slopes furnish raw materials for the forest industry and habitat for wildlife. The scenic mountains, wildlife, mineral springs, and pleasant summer climate is the basis of a thriving tourist and recreation industry. Most of the farms are operated on a part-time basis to supplement income from employment in the business centers of Covington, Clifton Forge and Lexington.

Available historical data generally indicates that the acres in cultivation on farms in Virginia and employment on farms and in related industries reached a peak about 1880. By 1940 there were about 17 percent fewer acres in cultivation in the State and by 1969 the acres in cultivation had dropped to about 54 percent of the 1880 figure. Although the effects of mechanization and other efficiencies account for a substantial portion of the reduced acreage, the data indicate that the impact of agriculture on the Basin's economy has dropped sharply since 1940, especially when related to the tremendous expansion of other industries and businesses.

Social Structure and Institutional Arrangements

The political structure has the major local government authority vested in the town, city or county. Virginia's large cities are independent of the counties which surround them. The Basin includes



USDA-SCS-HYATTSVILLE, MD. 1970

13 independent cities, 79 towns and 41 counties partly or wholly within its boundaries.

The majority of the towns have the mayor-council form of government. Most of the independent cities have city managers as the operating head of government functions. Each county also has a Board of Supervisors. Each of the local entities is included in a Regional Planning District set up by the State.

Soil and Water Conservation Districts are political subdivisions of the State comprised of one or more counties. A Board of Directors for each District provides leadership for coordinating conservation and land use programs. All counties in the Basin are included in the Districts.

Transportation[1/]

Water

Hampton Roads ranks second in commerce among Atlantic Coast ports.[2/] The smaller inland ports of the upper James River, including Richmond and Hopewell, handled 5,194,900 tons of cargo in 1967. The port at Richmond is located farther west than any other major port on the North Atlantic Seaboard.

Highway

Interstate highway travel in Virginia is facilitated by an excellent system of interstate highways, U. S. primary highways, Virginia primary highways and Virginia secondary highways (Figure 8). Easy access to all the major urban areas is provided.

Interstate 81 provides a north-south path through the mountainous western counties and Interstate 95 connects Richmond and Petersburg with Washington, D. C. and metropolitan centers both to the north and to the south. Interstate 64, when completed, will link Hampton Roads, Richmond, and other cities of the seaboard with the mountains and Interstate 81 in the western part of the Basin.

Freight service is provided by numerous motor freight carriers, both inter- and intrastate. Overnight service is usually available

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1/ Major portions of this section were obtained from James River Basin, Volume II, Economic Base Study, Division of Water Control Management, Virginia Department of Conservation and Economic Development, Planning Bulletin 214, 1969.

2/ This is measured in tonnage. Coal was the major export item and petroleum the major import item.

with fast daily service provided in some cases. The carriers connect the Basin counties with each other and with the major cities of the East Coast. Connections with the Mid-West and South are also available.

Rail

Rail service is excellent (Figure 9). The principal north-south lines - Seaboard Coast Line; Richmond, Fredericksburg and Potomac Line; and Southern Line - connect with leading railroads to the north at Washington, D. C. East-west lines with terminals in Hampton Roads are routed across the State by way of Richmond, Petersburg, Lynchburg, and Roanoke directly west to population centers in the Mid-West. Major east-west carriers are the Norfolk and Western Railway and the Chesapeake and Ohio Railway. The Penn-Central Railroad maintains a line running the length of the Eastern Shore from points north. Several shorter lines connect with the main lines to bring rail transportation to all sections of the Basin.

Air

Air transportation is available at major metropolitan areas, with major airports at Richmond, Newport News, Norfolk, Charlottesville, and Lynchburg (Figure 10). There is air service at Hot Springs which is easily accessible from Roanoke. Major airlines serve most of these airports.

Population

Table III-1 shows historical population figures for each county and subarea of the James River Basin. The total Basin population was 667,000 persons in 1940. In 1960, the population was 882,000 persons, an increase of 32 percent. By 1970, the population had increased to 997,000 persons, a 13 percent increase over 1960 and more than 49 percent greater than in 1940. Subarea 3 was the leader in population growth, showing an 84.5 percent increase from 1940 to 1970. In 1970, 65 percent of the total Basin population was living in Subarea 3.

Population projections for the year 2020 range from 1,752,000 to 2,262,000 (Table III-2). This is a 76 to 127 percent increase over the 1970 population. Three sets of projections are shown in Table III-2 to encourage planners to use flexible planning methods. The OBE[1] and State of Virginia projections are similar, with the NPA

[1] Office of Business Economics (now Bureau of Economic Analysis), U. S. Department of Commerce.

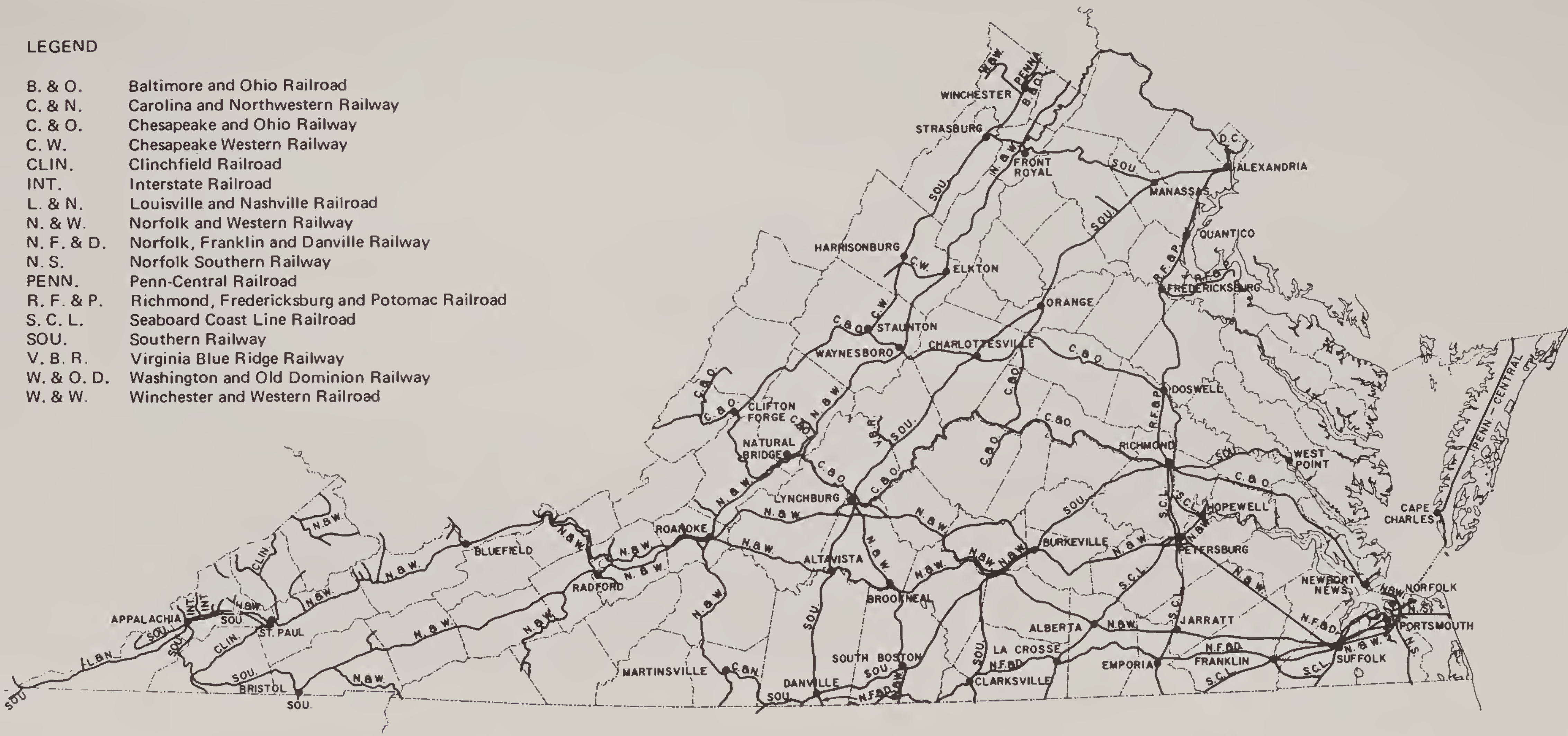
Figure 8

USDA-SCS-HYATTSVILLE, MD. 1970

ROUTES OF RAILROADS IN VIRGINIA
WITH PRINCIPAL JUNCTION POINTS - 1969

LEGEND

B. & O. Baltimore and Ohio Railroad
C. & N. Carolina and Northwestern Railway
C. & O. Chesapeake and Ohio Railway
C. W. Chesapeake Western Railway
CLIN. Clinchfield Railroad
INT. Interstate Railroad
L. & N. Louisville and Nashville Railroad
N. & W. Norfolk and Western Railway
N. F. & D. Norfolk, Franklin and Danville Railway
N. S. Norfolk Southern Railway
PENN. Penn-Central Railroad
R. F. & P. Richmond, Fredericksburg and Potomac Railroad
S. C. L. Seaboard Coast Line Railroad
SOU. Southern Railway
V. B. R. Virginia Blue Ridge Railway
W. & O. D. Washington and Old Dominion Railway
W. & W. Winchester and Western Railroad



Virginia Division of Industrial Development

Figure 9

USDA-SCS-HYATTSVILLE, MD. 1970

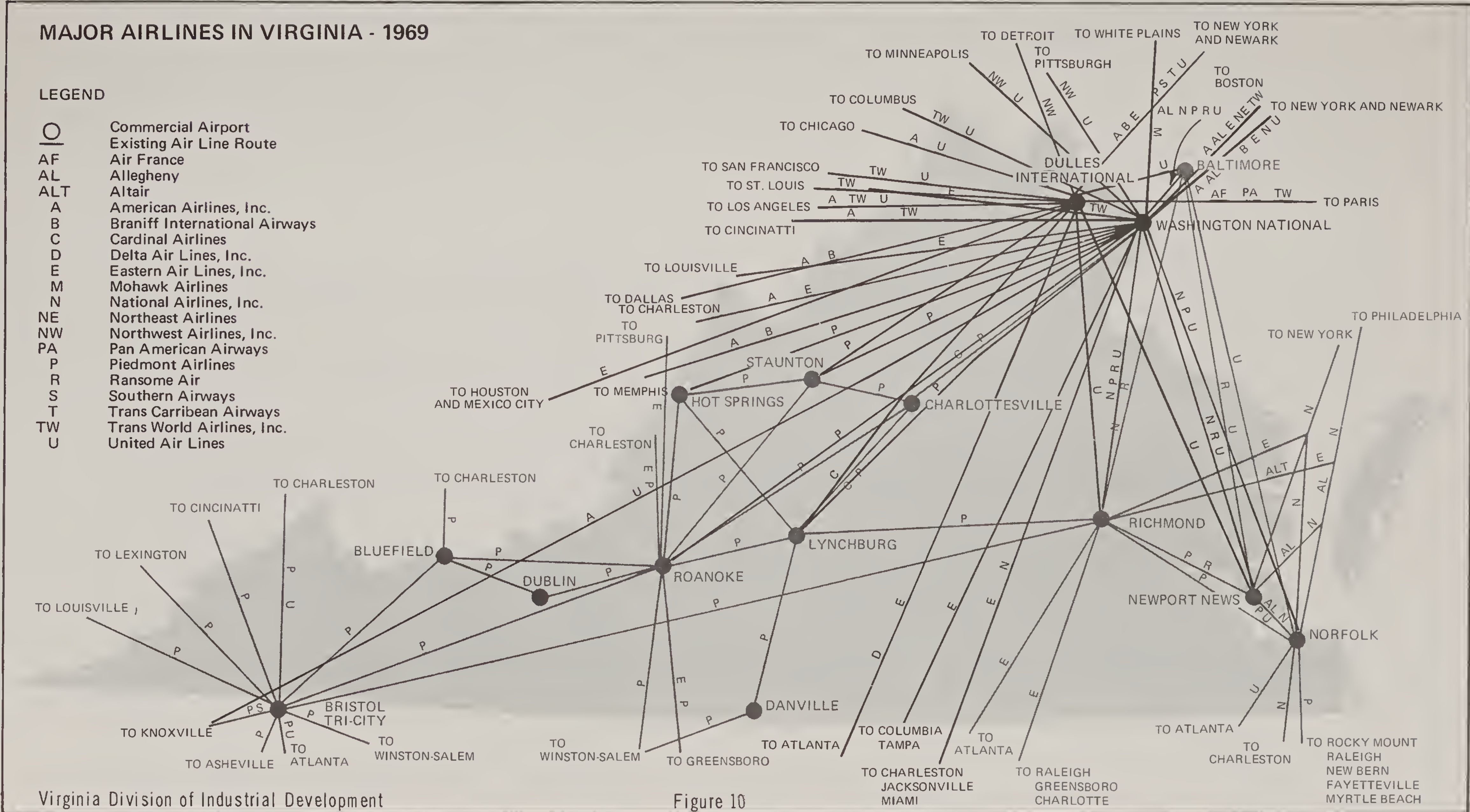


Figure 10

USDA-SCS-HYATTSVILLE, MD. 1970

Table III-1. Population for counties and independent cities, 1940, 1950, 1960 and 1970, James River Basin

Subarea and County or independent city1/	1940	1950	1960	1970	Annual Change 1940-1970	Annual Change 1960-1970
					Percent	
Subarea 1	88,150	87,000	87,844	88,119	0.00	-0.03
Alleghany County	16,388	17,279	12,128	12,461	-0.79	0.27
Bath County	7,191	6,296	5,335	5,192	-0.92	-0.26
Botetourt County	16,447	15,766	16,715	18,193	-0.35	0.88
Craig County	3,769	3,452	3,356	3,524	-0.21	0.50
Highland County	7,875	4,069	3,221	2,529	-1.60	-2.14
Rockbridge County	18,470	17,383	16,507	16,637	-0.33	0.08
Buena Vista City	4,335	5,214	6,300	6,425	1.60	0.19
Clifton Forge City	6,461	5,795	5,268	5,501	0.49	0.44
Covington City	6,300	5,860	11,062	10,060	1.98	-0.90
Lexington City	3,914	5,976	7,537	7,597	3.13	0.07
Subarea 2	220,434	228,177	242,248	261,942	0.62	0.81
Albemarle County	24,652	26,662	30,969	37,780	1.77	2.19
Amelia County	8,495	7,908	7,815	7,592	-0.35	-0.28
Amherst County	20,273	20,332	22,953	26,072	0.95	1.35
Appomattox County	9,020	8,764	9,148	9,784	0.28	0.69
Buckingham County	13,398	12,288	10,877	10,597	-0.69	-0.25
Cumberland County	7,505	7,252	6,360	6,179	-0.58	-0.28
Fluvanna County	7,088	7,121	7,227	7,621	0.25	0.54
Goochland County	8,454	8,934	9,206	10,069	0.63	0.93
Greene County	5,218	4,745	4,715	5,248	0.01	1.13
Nelson County	16,241	14,072	12,752	11,702	-0.93	-0.82
Nottoway County	15,556	15,479	15,141	14,260	-0.27	-0.58
Powhatan County	5,671	5,556	6,747	7,696	1.19	1.40
Prince Edward Co.	14,922	15,398	14,121	14,379	-0.12	0.18
Charlottesville	19,400	25,969	29,427	38,427	3.34	3.21
Lynchburg City	44,541	47,727	54,790	54,083	0.71	-0.13
Subarea 3	354,511	441,928	544,747	647,150	2.75	1.87
Charles City Co.	4,275	4,676	5,492	6,158	1.46	1.21
Chesterfield Co.	27,989	40,400	71,197	76,855	5.81	0.79
Henrico County	41,960	57,340	117,339	154,364	8.92	3.15
Isle of Wight Co.	13,381	14,906	17,164	18,285	1.22	0.65
James City County	4,907	6,317	11,539	17,853	8.79	5.47
New Kent County	4,092	3,995	4.504	5,300	0.98	1.76
Prince George Co.	12,226	19,679	20,270	29,092	4.59	4.35
Surry County	6,193	6,220	6,220	5,882	-0.16	-0.54
Colonial Heights	3,194	6.077	9,587	15,097	12.42	5.74
Hopewell City	8,679	10,219	17,895	23,471	5.68	3.11
Petersburg City	30,631	35,054	36,750	36,103	0.59	-0.17
Richmond City	193,042	230,310	219,958	249,621	0.97	1.34
Williamsburg City	3,942	6,735	6,832	9,069	4.33	3.27
Total	663,095	739,847	857,917	996,758		

1/ Source: Economic Data Summaries for Counties and Independent Cities, Virginia Governors Office, Division of State Planning and Community Affairs, Richmond, Virginia.

Table III-2. Projected population by subarea, Office of Business Economics, National Planning Association and Virginia, by year, James River Basin

Subarea	1980			2000			2020		
	OBE	NPA	Virginia	OBE	NPA	Virginia	OBE	NPA	Virginia
Total - Subarea 1	104,900	90,100	90,300	128,600	92,970	99,800	158,000	110,000	114,300
% of NPA	116	100	100	138	100	107	144	100	104
Total - Subarea 2	293,300	313,800	288,300	366,300	423,200	362,000	477,000	650,000	460,800
% of NPA	93	100	92	87	100	86	73	100	71
Total - Subarea 3	731,900	814,400	755,000	922,600	1,141,300	991,300	1,117,000	1,502,000	1,258,400
% of NPA	90	100	93	81	100	87	74	100	84
Basin Total	1,130,100	1,218,300	1,133,600	1,417,500	1,657,470	1,453,100	1,752,000	2,262,000	1,833,500
% of NPA	93	100	93	86	100	88	77	100	81

Sources: OBE: Furnished by Office of Business Economics, U. S. Department of Commerce.

NPA: Summary, Economic Base Study, Chesapeake Bay Drainage Basins, National Planning Association, Washington, D. C., Feb., 1967.

Virginia: Virginia Division of State Planning and Community Affairs, Governor's Office, Statistical Information Series No. 71-1, March, 1971.

projections[1] being somewhat higher for all subareas, except Subarea 1. State of Virginia projections reflect revisions made after release of 1970 Census of Population data. OBE and NPA projections are based on pre-1970 data. The intermediate projection (VA) was used to evaluate the problems and needs of the Basin in this study.

Table III-3 shows annual historical and projected growth rates for the three subareas and for the entire Basin. Subarea 3 has grown the fastest historically and will continue to lead other subareas in the future. Subarea 2 will begin to grow much faster as the Richmond Metropolitan Area grows toward the west. By 2020, it is estimated that 69 percent of the Basin population will live in Subarea 3 with 25 percent living in Subarea 2. Any future population is assumed to be more highly educated, possess more skills, have more purchasing power and demand more goods and services.

Table III-3. Annual historical and projected[1] growth rates, James River Basin

Growth rates	Subarea 1	Subarea 2	Subarea 3	James River Basin
		Percent		
1940-1950	0.11	0.35	2.47	1.44
1950-1960	0.20	0.62	2.33	1.56
1960-1970	-0.72	0.81	1.87	1.30
1940-1970	-0.14	0.62	2.75	1.65
1970-1980	0.25	1.01	1.67	1.37
1980-2000	0.53	1.28	1.56	1.41
2000-2020	0.73	1.36	1.35	1.31
1970-2020	0.59	1.52	1.89	1.68

1/ Based on State of Virginia Projections.

Source: Table III-1 and Table III-2.

Historical and projected population numbers are disaggreated into several categories in Table III-4. Historical and projected total population numbers were obtained from Tables III-1 and III-2. Rural and rural farm population projections were obtained by applying

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1/ NPA projections were determined by applying NPA growth rates by Chesapeake Bay region, weighted by 1965 population, to the subregions of the James River Basin. Minor adjustments were made to reflect an accelerated rate of growth in Subarea 3.

linear regression techniques to county population figures for 1940, 1950, 1960, and 1970. Rural non-farm population projections were obtained by subtraction as were urban projections. The actual numbers in each subcategory of total population in future years will depend upon the timing of future annexations by the independent cities.

Table III-4. Population mix projections, by subarea, by year, James River Basin

Subarea	Year	Total Population [1/]	Urban	Rural [2/]	Rural Farm	Rural Non-farm
Subarea 1	1940	92,064	24,924	67,140	35,573	31,567
	1960	94,961	37,715	57,246	11,715	45,531
	1970	88,119	29,583	58,536	7,992	50,544
	1980	90,300	38,800	51,500	6,900	44,600
	2000	99,800	47,500	52,300	5,000	47,300
	2020	114,300	58,200	56,100	4,100	52,000
Subarea 2	1940	220,434	70,115	150,319	111,230	39,089
	1960	242,248	94,309	147,939	37,164	110,775
	1970	261,942	108,270	153,672	22,553	131,119
	1980	288,300	117,800	170,500	15,500	155,000
	2000	362,000	137,500	224,500	10,700	213,800
	2020	460,800	151,000	309,800	7,600	302,200
Subarea 3	1940	354,511	239,488	115,023	40,991	74,032
	1960	544,747	407,440	137,307	14,479	122,828
	1970	647,150	520,381	126,769	14,326	112,443
	1980	755,000	500,900	254,100	9,600	244,500
	2000	991,300	678,300	313,000	5,700	307,300
	2020	1,258,400	901,400	357,000	4,200	352,800
James River Basin	1940	667,009	334,527	332,482	187,794	144,688
	1960	881,956	539,464	342,492	63,358	279,134
	1970	997,211	658,234	338,977	44,871	294,106
	1980	1,133,600	657,500	476,100	32,000	444,100
	2000	1,453,100	863,300	589,800	21,400	568,400
	2020	1,833,500	1,110,600	722,900	15,900	707,000

1/ Total population equals urban plus rural.
2/ Rural equals rural farm plus rural non-farm.

Table III-5 shows percentage changes in the numbers for selected time periods.[1/] Total population is expected to grow much faster in Subareas 2 and 3 than in Subarea 1. The growth will take place in the urban and rural non-farm areas surrounding Richmond. The rural non-farm areas of Subarea 3 are expected to grow much faster than similar areas in Subareas 1 and 2. Subarea 1 is expected to grow very slowly. The lack of jobs in the area will be partially offset by the growth of vacation and retirement communities.

Table III-5. Percentage changes in population mix, by subarea, James River Basin

Subarea and Period	Total Population	Urban	Rural	Rural Farm	Rural Non-farm
Subarea 1					
1940-1970	-4.3	18.7	-12.8	-77.5	60.1
1970-1980	2.2	30.8	-12.2	-13.7	-11.8
1970-2020	24.8	89.3	- 6.0	-48.7	2.9
Subarea 2					
1940-1970	18.8	54.7	2.1	-79.7	235.4
1970-1980	19.8	18.2	20.9	-31.3	18.2
1970-2020	148.1	96.4	184.1	-46.3	130.8
Subarea 3					
1940-1970	82.5	117.6	9.6	-65.1	51.9
1970-1980	25.8	3.7	117.5	-33.0	117.4
1970-2020	132.1	106.5	238.1	-70.7	213.8
Basin total					
1940-1970	49.5	97.0	1.7	-86.1	103.3
1970-1980	22.2	7.3	51.2	-28.7	51.0
1970-2020	126.8	104.1	171.3	-64.6	140.4

Source: Derived from Table III-4.

All categories of population, except rural farm, show growth. The rural farm category shows population decreases in all projected

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1/ The population numbers and percentage changes shown in Tables III-4 and III-5 are based upon the Virginia projections shown in Table III-2. Population projection ranges can be obtained by using the OBE and NBA projections also shown in Table III-2.

time frames which is consistent with the long term trend. The rural non-farm population shows an 11.8 percent decrease in Subarea 1 between 1970 and 1980, but bounces back to a 2.9 percent increase between 1970 and 2020. This reflects the increasing popularity of the region as a tourism and recreation center.

During the 1940 to 1970 period, rural farm population declined from 28 percent to only 4.5 percent of total Basin population. This is a part of a national trend which has occurred because of (1) the decreasing profitability of small farm units, (2) the lack of capital with which to expand the size of operation, (3) the low productivity of most soils in the region and a scarcity of well protected flood plain land and (4) the increasing availability of off-farm employment. The decreasing profitability of small farm units has caused some farm operators to obtain full-time off-farm employment, thus enabling the remaining operators to expand the size of their units. Other operators have obtained part-time off-farm employment to supplement their farm income. The problems of soil productivity and flood plain protection are discussed in greater detail in Chapter IV. Rural farm population is projected to be only 2.8 percent of total Basin population in 1980 and only 0.9 percent in 2020.

Population density in 1970 ranged from 10 persons per square mile in Bath and Craig Counties to 674 persons per square mile in Henrico County. Population densities in the independent cities in 1970 ranged from 1,375 persons per square mile in Clifton Forge to 4,513 persons per square mile in Petersburg and 4,160 persons per square mile in Richmond.

Employment

Increased population requires more job opportunities. Historically, a 1 percent increase in population has meant approximately a 0.36 percent increase in the number of jobs demanded. This proportion has remained nearly constant since 1950. It is expected to increase to 1.41 percent, and possibly higher by the year 2020, as a result of decreases in the number of children born per person and increases in the number of working women.

Total Employment

Total employment in the James River Basin increased from 246,278 in 1940 to 394,994 in 1970, a 60 percent increase. A breakdown of employment by three major categories is presented in Table III-6. Employment in agriculture includes those persons employed in agriculture, forestry, and fisheries. Employment in manufacturing includes those persons employed in establishments engaged in the mechanical or chemical transformation of inorganic or organic substances into new products. Employment in manufacturing includes

those persons employed in mining, contract construction, transportation and communications, utilities, wholesale and retail trade, finance, insurance and real estate, services, government, and all other industries.

Table III-6. Employment by major categories, by year, James River Basin

Category	1940	1950	1960	1970	1980	Projections 2000	2020
				Number			
Agriculture	40,815	29,031	17,142	10,170	8,000	6,000	5,000
Manufacturing	59,692	70,011	82,745	96,945	115,000	142,000	172,000
Non-agricultural Non-manufacturing	145,771	200,423	236,763	287,879	377,000	559,000	816,000
Total	246,278	299,465	336,650	394,994	500,000	707,000	993,000

Source: Growth Patterns in Employment by County, 1940-1950 and 1950-1960, Volume 5, Southeast, U. S. Dept. of Commerce, 1965 and 1970 Census Report PC(1)-C48, Table 123.

In 1940, 17 percent of the jobs were agricultural. In 1970, only 2.6 percent of the jobs were agricultural. Manufacturing only slightly increased its share of total jobs from 24 percent in 1940 to 25 percent in 1970. However, non-agricultural and non-manufacturing categories increased its share from 59 percent in 1940 to 73 percent in 1970. In 2020, agricultural jobs are expected to account for only 0.5 percent of the total number of jobs available. Manufacturing is projected to comprise 17 percent of the total while non-agricultural, non-manufacturing is estimated to increase its share to 82 percent of the total number of jobs available.

Employment in Water-Using Industries

The significant water-using industries are food and kindred products; textiles; paper; chemicals; petroleum; leather and rubber manufacturing; stone, clay, and glass products; and primary metals. Table III-7 indicates that total employment in the heavy water-using industries increased approximately 78 percent in the 1950 to 1965 period. It is projected in increase a moderate nine percent to only 46,900 by 1980, but by the year 2020 employment in these industries is expected to be 73,000, a 71 percent increase over 1965.

Table III-7. Employment in major water-using industries, by year, James River Basin

Industry	1950	1960	1965	1980	Projections 2000	2020
				Number		
Food and kindred products	4,299	6,781	8,636	10,400	10,700	11,000
Textiles	4,250	3,667	3,565	3,800	3,600	3,000
Paper and Printing	7,653	9,515	10,209	8,800	13,200	20,000
Chemicals	3,946	6,772	12,304	14,400	15,800	17,000
Petroleum, leather, and rubber	234	241	583	800	1,000	1,000
Stone, clay, and glass products	880	1,018	2,249	2,200	3,200	5,000
Primary & fabricated metal products	3,030	5,533	5,574	6,400	9,900	15,000
Total	24,292	33,527	43,120	46,800	57,400	72,000

Source: Growth Patterns in Employment by County, 1940-1950 and 1950-1960, Volume 5, Southeast, U. S. Dept. of Commerce, 1965.

Employment in Forest Industries

Forest products have always been an important base for employment (Table III-8). Almost one-half of the total employment is found in secondary manufacturing. Forest management and harvesting include only 13 percent of the total employment. Primary manufacturing and construction each represent 15 percent of the total employment.

Present and projected employment in forest based activities is shown in Table III-8. Improved technology will increase the volume of wood processed by each employee. The volume of timber harvest is expected to increase, but total employment is expected to decrease slightly by 1980; hold steady through 2000; then decrease by 20 percent in 2020. Due to technology, employment in construction will show a steady decrease by 2020, but employment in transportation and marketing will show a steady increase through 2020. These projections of employment are based on the continuation of current intensities of forest management and the expectation that recent trends in the rate of harvest will not change appreciablv.

Employment in Recreation Industries

Employment in most recreation industries is seasonal. The recreation industry competes for labor resources during the summer months, but usually leaves labor resources unemployed during the off-season.

Table III-8. Employment in timber based economic activities by year, James River Basin

Economic Activity	Employment			
	1966	1980	2000	2020
	Number			
Forest management	633	844	1,256	1,598
Harvest forest products	4,329	3,735	3,186	2,417
Primary manufacturing	5,844	5,028	4,469	4,022
Secondary manufacturing	17,588	18,350	18,523	11,079
Construction attributed to timber	5,717	5,276	4,639	4,083
Transportation and marketing attributed to timber	4,061	4,704	5,859	7,299
Total	38,172	37,937	37,932	30,498

Source: Virginia Forest Survey 1966 and the "Economic Importance of Timber in the United States", Forest Service Miscellaneous Publication 941, 1963 and published data of the Virginia Employment Commission.

Estimates of employment which support the recreation industry are unavailable. However, employment will show similar increases, as does income, through added expenditures in a community and multipliers can also be computed to show employment changes. In a study of 376 Appalachian counties, recreational employment multipliers were computed and ranged from 1.13 to 2.63.1/ These values imply that on the average for each direct addition to employment associated with the exogenous sector there will be approximately 0.13 to 1.63 persons added to employment roles in the endogenous sector. In general, the multiplier size varied directly with the employment of the county. In counties with large numbers of employees, the multipliers were large and, conversely, in counties with few employees the multipliers were small. This does not imply that by locating a recreational complex in a county with a large employment the growth of employment will be the greatest. There must be unemployed resources available to meet the new demand created in the successive rounds of expenditures. Finally, there must be a demand for the recreational services in the area in question. Unless these conditions are met, proper operation of the multipliers could not be assumed.

1/ "Recreation as an Industry", a report prepared for the Appalachian Commission, Robert R. Nathan Associates, Inc.

Employment Changes

The growth rate in employment for all industries in the Basin was 37 percent between 1940 and 1960 versus 58 and 46 percent in Virginia and the United States, respectively (Table III-9). Employment in the Basin grew faster than in the State in four industries (Armed Forces, other transportation equipment, manufacturing forestry and fisheries, and motor vehicles and equipment manufacturing). The Basin exceeded the growth rate for the Nation in 13 industries.1/ Four industries in the Basin declined between 1940 and 1960. These same four industries also declined in the State and in the Nation. Twenty of the 32 industries shown outperformed the industry composite growth rate. This figure was 19 for the State and 20 for the Nation: the Basin showed a 37 percent growth rate for the forestry and fisheries industry which declined both in the State and in the Nation. Agriculture in the Basin declined 59 percent only slightly more than in the State and Nation.

Commuting Patterns

A matrix showing commuting patterns for most of the counties and independent cities in the Basin for 1960 was developed and is shown in Table III-10. The numbers are based on a 25 percent sample taken during the 1960 census.

An analysis of commuting patterns reveals many interesting facts about the regions for which data is available. When compared to the regional work force, it indicates the extent of a region's employment base, i.e. what percentage of the work force is employed locally. Commuting patterns also indicate from which surrounding regions an employment center draws its workers. Commuting patterns can be used as an aid in the decision making process, i.e. where to locate recreation areas, water supplies and highways and how to allocate revenue-sharing funds.

In the James River Basin most counties, and surprisingly, some independent cities, have a net outflow of commuters (Table III-10). In the case of the independent cities however, the net flows are very dependent upon where the cities' boundaries lie. As expected, counties surrounding large employment centers have a net outflow of commuters larger than their within - county employment. Amelia County is an exception. Amelia County is not immediately adjacent to a large employment center.

1/ Appendix B. Table 4 shows a net increase in employment in the Basin of 90,000 from 1940-1960. Eighty-four percent of the net increase was in only seven industries. Two industries, agriculture and private households, showed a combined decrease in employment of 29,000. Appendix Tables 1, 2, and 3 show similar information for each of the subareas.

Table III-9. Percent change in employment by industry, Virginia, and the United States, 1940-60, James River Basin

Industry	James River Basin 1/	State of Virginia	United States
		Percent Change	
1. Armed Forces	Inf.	380	467
2. Electrical and other machinery mfg.	439	737	185
3. Communications	139	184	108
4. Medical, other professional services	127	172	128
5. Other transportation equipment mfg.	116	39	218
6. Public administration	113	241	116
7. Printing and publishing mfg.	95	163	80
8. Finance, insurance, and real estate	92	149	83
9. Food and kindred products mfg.	91	102	65
10. Trucking and warehousing	82	95	80
11. Business and repair services	77	136	86
12. Apparel manufacturing	74	130	45
13. Eating and drinking places	73	124	61
14. Industry not reported	71	263	278
15. Other transportation	68	105	63
16. Utilities and sanitary services	62	91	65
17. Other retail trade	62	107	63
18. Contract construction	59	88	84
19. Wholesale trade	59	115	83
20. Forestry and fisheries	37	-29	-14
21. ALL INDUSTRIES	37	58	46
22. Motor vehicles and equipment mfg.	29	21	46
23. Chemicals and allied products mfg.	27	55	96
24. Other and miscellaneous mfg.	20	59	58
25. Textile mill products mfg.	19	21	-17
26. Entertainment, recreation services	17	57	27
27. Lumber, wood products, furniture mfg.	16	18	14
28. Hotel and other personal services	13	36	15
29. Food and dairy products stores	5	47	13
30. Railroad and railway express	-17	-23	-17
31. Mining	-24	-20	-29
32. Private households	-27	-14	-18
33. Agriculture	-59	-55	-50

1/ Industries in order of percent change.

Source: U. S. Department of Commerce, Growth Patterns in Employment by County, 1940-60, Volume 5, 1965

Employment Shifts

In Appendix B, Tables 5 through 8 show employment change and its components for the Basin and each of the subareas for the period 1940-1960.

Two potentially discouraging trends can be noted in Appendix B, Table 8. The first is that the Basin may not be participating fully in the expansion of growth industries. For instance, the regional share of employment in the chemicals and allied products manufacturing industry decreased during the period by 4,758, while the industrial mix of this recognized growth industry increased by 3,277. The second trend indicates that there is an increasing relative share of industries which are declining in importance (industrial mix) relative to other industries in the Basin.

In summary, the information shown in Appendix B, Tables 5 through 8 is somewhat pessimistic by its implications. If the planners want to maintain or increase Basin viability, they must begin to create those conditions necessary to attract growth industries into the region.

Income

Personal and Per Capita Income

Personal income data for the three subareas, the James River Basin, the State of Virginia, and the United States are presented in Table III-11. Personal income increased for the James River Basin from 974 million dollars in 1959 to 2,923 million dollars in 1970, an increase of 200 percent. This is less than the 263 percent increase for Virginia, but more than the 151 percent increase registered by the United States.

Personal income for the Basin is estimated to be 22,000 million dollars by the year 2020, a 653 percent increase over the 1970 figure. This compares with a 1,364 percent increase for the State and a 625 percent increase for the United States for the same period.

Based on the 1960 dollar base, per capita personal income in the Basin is projected to be $9,700 in 2020 (Table III-11). This will be $1,300 below the State figure and $300 below the figure for the United States.

Table III-12 shows the per capita income for each county and independent city in the James River Basin in 1970 and their percentage of the United States per capita income. Per capita income in the Basin in 1960 was $2,931 which is $82 less than per capita income for Virginia and 86 percent of the United States' per capita income of $3,415 (1969 figure). Only Henrico County was above the United States in per capita income figure

Table III-10. Commuting Patterns, James River Basin, 1960.

From / To	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Highland County	853	35																	
2. Bath County	4	1667	46			8	8												
3. Alleghany County 1/		32	8604	9	15		8												
4. Craig County				734	18		5												
5. Botetourt County			283	5	3231	281	58	131											
6. Rockbridge County 2/		8	8		57						8								
7. Covington City		29																	
8. Clifton Forge City					15														
9. Lexington City 2/																			
10. Buena Vista City 2/											43								
11. Amherst County						44				23	3941	214			17	4			
12. Nelson County						16					119	2620	265		19	9			
13. Albemarle County											4	101	8773	28			16		
14. Greene County													267	745			4		
15. Appomattox County											23	43			2412	30			3
16. Buckingham County											24	28	90		29	2564	93		24
17. Fluvanna County													224			24	1429	37	5
18. Goochland County													4			8	23	1449	4
19. Cumberland County																29		47	1341
20. Powhatan County																		25	20
21. Amelia County																			4
22. Prince Edward County															59	16			56
23. Nottoway County																			
24. Lynchburg City						16				606	31			20					
25. Charlottesville City											13	2242	13		4				
26. Henrico County																		67	
27. Chesterfield County																		14	
28. New Kent County																			
29. Charles City County																			
30. Prince George County																			
31. James City County																			
32. Surry County																			
33. Isle of Wight County																			
34. Richmond City																		39	
35. Hopewell City																			
36. Colonial Heights City																			
37. Petersburg City 3/																			
38. Williamsburg City																			
Other In-Commuters	13		70	16	182						209	52	694	51	113	8	41	73	
Total In-Commuters	17	104	420	30	272						1036	482	3786	92	257	132	177	302	116
Net In-Commuters		2											2257						
Net Out-Commuters	81		385	323	1915						2551	723		648	597	465	582	770	467

From / To	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	Other Out-Commuters	Total Out Commuters
1. Highland County					5															58	98
2. Bath County																				36	102
3. Alleghany County 1/																				729	805
4. Craig County					4															326	353
5. Botetourt County																				1623	2187
6. Rockbridge County 2/																					
7. Covington City																					
8. Clifton Forge City																					
9. Lexington City 2/																					
10. Buena Vista City 2/																					
11. Amherst County					2902															383	3587
12. Nelson County					195	165														447	1205
13. Albemarle County						1007														373	1529
14. Greene County						210														259	740
15. Appomattox County					453															302	854
16. Buckingham County			140		8	7									33					95	597
17. Fluvanna County						280									37					98	705
18. Goochland County	39						106	32							684					172	1072
19. Cumberland County	29	13	296	9											30					116	583
20. Powhatan County	1312						11	127							494					40	717
21. Amelia County	16	1780	40	85			12	38				4			179		4	36		145	551
22. Prince Edward County		12	3926	148	11										32					256	626
23. Nottoway County		36	73	4176			18	33							65			40		291	556
24. Lynchburg City			4		19763	12														1256	1945
25. Charlottesville City					13	9371														203	2488
26. Henrico County	4						9959	1632	28	16	54	8			31023		56	58		1595	34541
27. Chesterfield County	8	9		12			638	9916		4	411				12053	593	232	1523		755	16205
28. New Kent County							66	18	761	8		50			226				81	257	706
29. Charles City County							92	5	155	550		59			338				128	124	901
30. Prince George County							4	190			6706		11		35					1678	1918
31. James City County									33	21		1420			11				1236	884	2185
32. Surry County											32		1334	164	11	47		7		257	518
33. Isle of Wight County													12	4308						1174	1186
34. Richmond City	18	11					2144	3186		22	93				76832	85	4	88		1212	6902
35. Hopewell City							4	429			507				175	4368	20	345		150	1630
36. Colonial Heights City							8	431			602				178	255	750	1598		159	3221
37. Petersburg City 3/		4						610			1693				202	546	292				
38. Williamsburg City							4			5		36			8				1825	396	445
Other In-Commuters		13	79	354	5452	407	774	449	75	13	446	577	29	1014	6453		71		1037		
Total In-Commuters	114	98	632	608	9013	2088	5224	7180	291	89	3928	730	52	1178	51262	1526	679		2482		
Net In-Commuters		2233	6	52	7068						2010				44360				2037		
Net Out-Commuters	603					400	29317	9025	415	812		1455	466	8		104	2542				

1/ Includes Clifton Forge City and Covington City.

2/ Data not available.

3/ Included in Dinwiddie County which is outside the Basin.

Source: U.S. Bureau of the Census, Census of Population, 1960 (unpublished tabulations based on a 25 percent sample).

Table III-11. Total personal and per capita income, James River Basin, Virginia, and United States, by year

Item	Unit	1950	1960	1970	1980	Projected 2000	Projected 2020	Percent Increase 1950-70	Percent Increase 1970-2020
Total Personal Income									
Subarea 1	Mil. Dols.	92	145	208	300	500	800	126.1	285
Subarea 2	Mil. Dols.	233	401	674	1,000	2,100	5,000	189.3	642
Subarea 3	Mil. Dols.	649	1,195	2,042	3,100	7,300	16,000	214.6	684
James River Basin	Mil. Dols.	974	1,742	2,923	4,300	9,800	22,000	200.1	653
State of Virginia 1/	Mil. Dols.	3,861	7,387	14,006	22,800	70,200	205,000	262.8	1364
United States 2/	Bil. Dols.	274.6	389.7	689.3	967	2,200	5,000	151.0	625
Per Capita Income									
Subarea 1	Dols.	1,131	1,532	2,355	3,300	5,400	7,300	108.2	210
Subarea 2	Dols.	1,022	1,657	2,573	3,200	5,000	7,700	151.8	199
Subarea 3	Dols.	1,614	2,194	3,155	3,800	6,400	10,700	95.5	239
James River Basin	Dols.	1,369	1,975	2,931	3,500	5,900	9,700	114.1	231
State of Virginia 1/	Dols.	1,222	1,853	3,013	3,500	6,500	11,000	146.6	265
United States 2/	Dols.	1,802	2,157	3,415	4,100	6,700	10,000	89.5	193

1/ Potomac-Shenandoah River Basin Comprehensive Water Resources Plan, Volume II - Economic Base Study, Division of Water Resources, Virginia Department of Conservation and Economic Development, 1968.

2/ 1969 data.

Source: Economic Base Study, Chesapeake Bay Drainage Basins, National Planning Association, 1967 Census of Population, 1960 and 1970.

in 1970 (108.7 percent). In 1960 there were three counties and four independent cities above the 1960 U. S. per capita income figure. In general, however, it appears that the average income gap between the State and the Nation is narrowing and that the Basin is narrowing its gap between both the State and the Nation.

Median Income

The median family income in the James River Basin in 1970 was $9,011 or 90 percent of the United States' $10,040 (1969 figure); while Virginia's median family income of $9,049 was 90 percent of the United States' (Table III-12). Henrico County, Chesterfield County, Colonial Heights City, and Williamsburg City has the highest median family incomes in the James River Basin with figures of $11,217, $11,174, $10,813 and $10,266, respectively. These figures range from $266 to $1,177 above the median family income for the United States. Bath and Cumberland Counties had the lowest median family incomes in 1970. The figure for Bath County was $5,424, 54 percent of the median family income for the United States, and the figure for Cumberland County was $5,365, only 53 percent of the United States' figure.

One measure of economic well-being is the number of families with annual incomes under the poverty level. Table III-12 also shows that in general, the counties with the lowest median family incomes have the highest percentage of families with incomes under the poverty level, while the counties with highest median family incomes have the highest percentages of people with incomes over $15,000.

Farm Income

Projected sales of farm products for each of the subareas and for the Basin are presented in Table III-13. Projected total sales for the Basin shows an increase from $88,327,000 in 1969 to $135,168,000 in 2020, a 62 percent change. Percentage increases in sales for individual subareas for the 1969 to 2020 period ranged from 32 percent to 87 percent. Percentage increases are expected to be higher in the western part of the Basin than in the eastern part.

Forest Income

Projected volume and value of forest land products harvested is shown in Table III-14. Both volume and value are expected to almost double by 2020. Each twenty years the volume and value of forest products harvest will increase approximately one-third. The 1965 harvest of 118.3 million cubic feet, valued at $180 million, is expected to increase to 224.7 million cubic feet, valued at $343 million by 2020.

Table III-12. Per capita and median family income as a percent of per capita income in the United States, 1970

Area	Per Capita Income: Dollars	Per Capita Income: Percent of U.S.	Median Family Income: Dollars	Median Family Income: Percent of U.S.	Percent less than Poverty level	Percent over $15,000
United States 2/	3,415	100.0	10,040	100.0	3/	3/
State of Virginia	3,013	88.2	9,049	90.1	12.3	19.8
James River Basin	2,931	85.8	9,011	89.8	11.9	17.1
Subarea 1	2,355	69.0	7,358	75.1	14.2	8.7
Alleghany County	2,294	67.2	7,545	75.1	14.7	7.7
Bath County	2,052	60.1	5,424	54.0	24.9	5.7
Botetourt County	2,482	72.7	8,217	81.8	11.2	11.2
Craig County	2,016	59.0	6,539	65.1	18.0	4.1
Highland County	1,889	55.3	5,542	55.2	21.9	3.8
Rockbridge County	2,206	64.6	7,011	69.8	16.6	6.5
Lexington City	2,581	75.6	8,646	86.1	12.3	20.0
Buena Vista City	2,310	67.6	7,854	78.2	11.0	8.4
Clifton Forge City	2,617	76.6	7,698	76.7	10.9	8.3
Covington City	2,557	74.9	8,133	81.0	11.8	7.7
Subarea 2	2,573	75.3	7,998	79.7	16.2	13.7
Albemarle County	3,042	89.1	8,949	89.1	13.0	20.3
Amelia County	1,842	53.9	5,805	57.8	26.2	8.8
Amherst County	2,141	62.7	8,434	84.0	12.0	10.9
Appomattox County	2,248	65.8	7,724	76.9	7.7	8.4
Buckingham County	1,707	50.0	5,661	56.4	28.8	6.8
Cumberland County	1,677	49.1	5,365	53.4	32.9	5.2
Fluvanna County	2,030	59.4	6,744	67.2	27.2	6.4
Goochland County	2,268	66.4	7,277	72.5	18.8	12.6
Greene County	1,892	55.4	6,712	66.9	21.8	5.8
Nelson County	1,787	52.3	5,677	56.5	28.6	5.4
Nottoway County	2,104	61.6	7,098	70.7	19.8	5.8
Powhatan County	2,461	72.1	7,523	74.9	18.4	11.3
Prince Edward County	2,225	65.2	6,843	68.2	22.8	10.3
Charlottesville City	3,190	93.4	9,231	91.9	9.0	18.2
Lynchburg City	3,045	89.2	8,855	88.2	11.3	17.9
Subarea 3	3,155	92.4	9,612	95.7	9.9	19.9
Charles City County	1,621	47.5	6,111	60.9	28.4	6.6
Chesterfield County	3,266	95.6	11,174	111.3	5.8	25.0
Henrico County	3,713	108.7	11,217	111.7	4.0	25.2
Isle of Wight County	2,075	60.8	7,658	76.3	19.9	7.8
James City County	2,422	70.9	8,835	88.0	10.8	15.9
New Kent County	2,169	63.5	6,879	68.5	20.5	10.7
Prince George County	2,563	75.1	8,776	87.4	9.1	14.2
Surry County	1,872	54.8	6,605	65.8	19.0	10.0
Colonial Heights City	3,397	99.5	10,813	107.7	4.2	21.6
Hopewell City	2,883	84.4	9,200	91.6	9.1	16.4
Petersburg City	2,544	74.5	7,815	77.8	16.7	12.7
Richmond City	3,168	92.8	8,673	86.4	13.3	17.4

1/ As defined by data presented in the 1967 City & County Data Book.
2/ Estimated 1969 data. 3/ Not available.
Source: U.S. Census of Population, PC(1)-C48, 1970.

Table III-13. Projections of farm product sales by subarea, by year, James River Basin[1/]

Subarea	1980	2000	2020
		Dollars	
Subarea 1	16,198,200	19,774,300	24,722,000
Subarea 2	46,354,400	58,498,200	73,811,000
Subarea 3	26,533,400	31,139,700	36,635,000
Basin Total	89,086,000	109,412,200	135,168,000

1/ The pitfalls accompanying projections of the future of small areas must be kept in mind when using these figures as a basis for planning.

Table III-14. Projected value and volume of forest products harvested, by year, James River Basin

Year	Value 1/	Volume Harvested
	1,000 dollars	million cubic feet
1965	179,741	118.3
1980	236,944	155.3
2000	302,245	198.1
2020	342,829	224.7

1/ Value in 1965 dollars and includes value added contributed to timber.

Source: Virginia Forest Survey 1966 and "The Economic Importance of Timber in the United States", Forest Service Miscellaneous Publication 941,1963.

Fish and Wildlife Income

The present and projected value of sport fishing in the economy of the Basin is difficult to assess. Cost for salt water charter boats and trout fishing equipment plus travel expenses are high compared to costs for an afternoon of pond or creek fishing. An approximation can be made by multiplying the estimated number of fishermen by the average expenditure of each fisherman. In 1965, a survey[1/] established the average expenditure per fisherman at \$103.19. The resultant value, in 1965 dollars, for 1960 was \$13,956,000. Based on projections of the number of fishermen anticipated in the year 2020, this figure would increase to about \$36 million.

The new industry of commercial trout production is making cautious progress in the Ridges and Valleys Subarea. The trout are raised in holding ponds fed by the numerous cold springs in the area. These are family-sized operations supplying commercial processors. Expansion of markets and production facilities could add substantially to the economy of the area.

The value of wildlife (hunting) in the economy is equally difficult to assess. An estimated 200,000 hunters participate in this form of recreation. At \$82.54[2/] expenditure per hunter in 1965, the overall value was about \$16.5 million. The number of hunters has not increased significantly in the past decade and only modest increases in hunting activity are anticipated in the future. Reasons cited are the encroachment of other land uses on wildlife habitat and competition of other recreational activities.

Recreation Income

Recreational expenditures are many and varied. The size of the enterprise varies considerably, ranging from the farmer providing lodging and hunting rights on his farm to the coastal beaches

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1/ National Survey of Hunting and Fishing, Fish and Wildlife Service, Department of Interior, 1965. More recent information will be available in the forthcoming Corps of Engineer Report on the James River Basin. This report will contain a projective analysis of fishermen days and hunter days as shown in the Bureau of Outdoor Recreation Report, USDI, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife.

2/ National Survey of Hunting and Fishing, Fish and Wildlife Service, Department of Interior, 1965.

where entire cities have developed solely for the provision of services to recreationists. Recreational services have been provided by Federal and States governments with a minimum of opposition from the private sector. In fact, investment by Federal and State agencies in recreational areas and facilities is generally welcomed by private investors and is often necessary for the development of an area to its fullest potential. The development of roads, water impoundments, large land acquisitions, and the enhancement of scenic areas often cannot be done profitably by private investors.

Per capita recreational expenditures for all occasions and all seasons amounted to just over $103 per year.1/ Vacations are by far the most important recreational expenditure accounting for about three-fourths of the total expenditure. Outings accounted for a slightly greater expenditure than did trips.

Approximately half of all expenditures are made in the summer for all occasions - vacations, trips, and outings. The next largest expenditure is made in the fall, with the least - or slightly more than 10 percent - being made in the winter. The relative proportion spent by occasion did not vary greatly for each season.

Transportation accounted for about one-third of all expenditures regardless of occasion or season of the year. Food accounted for another fourth of the total expenditures. Outdoor and other recreational fees and miscellaneous expenses do not account for a large portion of the expenditures individually but together represent a significant portion of the total expenses. The proportion spent for these items on outings was considerably greater than on trips or vacations.

Gross recreational expenditure is a function of per capita expenditure and population over 12 years of age. The gross recreational expenditure for the James River Basin for the period June 1960 to May 1961 has been estimated at $125.9 million.2/

1/ Outdoor Recreation Resources Review Commission, Report No. 19, U.S. Government Printing Office, 1962.

2/ Taken from internal data developed by Economic Research Service for the North Atlantic Regional Study. The estimate is based on per capita expenditures published in the Outdoor Recreation Resources Review Commission Report.

Water-based recreational expenditures cannot be separated entirely. Nevertheless, percentages for determining the amount expended for water recreation were developed. If the major purpose of a trip is for water activities, then expenditures made on that trip are considered as expenditures directly attributable to water facilities. Forty-one percent of the trips were made for water activities and thirty-five percent of the outings for water activities.[1/] As would be expected, the water activities were a purpose of the trip more in the summer than in any other season. Expenditures for water-based recreation are more than 60 percent of total summer expenditures, whereas for the entire year they are approximately 40 percent.

Personal and Business Taxes

All the cities and counties in the Basin rely on real estate and machinery and tool taxes for revenue. All except Hopewell City have a personal property tax. Other taxes are used in various combinations to produce revenue needed to provide the necessary public services (see Table III-15).

The data shown in Table III-15 varies for years between 1966 and 1970. The Virginia Department of Taxation should be consulted for up-to-date rates and combination of various taxes imposed by each county and/or city.

Land Use

Land used for agricultural production has exhibited a marked continued decrease from 1949 to the present. Not unlike projected national trends, future decreases in cropland and pasture land can be expected to continue. Present and projected data for agricultural land use appears in Table III-16.

An overview of the data indicates an expected increase in forest land with a simultaneous reduction in cropland and pasture. By the year 2020, 516,000 acres of cropland are expected to shift out of production and into alternative uses. The projected reduction of pasture is expected to total 310,000 acres by the year 2020.

The greatest change in cropland is expected to occur in Subarea 2 and amount to a loss of 315,000 acres. This Subarea will also experience the greatest shift in pasture with a decrease of 204,000 acres. Subarea 2 will lead the other two areas in acreage gain in

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1/ North Atlantic Regional Water Resources Study, "Effects of Recreational Developments on Rural Income", NAR Water Resources Study Coordinating Committee, November, 1969.

Table III-15. Tax assessments for counties and cities, varying years, 1966-1970, James River Basin

County or City	Real Estate		Machinery & Tools		Personal Property		Merchant Capital		Merchant License	Utility	Sales (percent)	Vehicle License
	Assessment Ratio	True Tax per $100	Assessment Ratio	True Tax per $100	Assessment Ratio	True Tax per $100	Assessment Ratio	True Tax per $100				
Highland County	0.400	$ 1.00	0.25	$ 1.00	0.25	$ 1.00	0.20	$ 0.80	None	None	None	$ 10.00
Bath County	0.235	0.60	0.25	0.54	1/	2.16	1/	2.16	None	None	1.00	None
Alleghany County	0.174	0.70	0.10	0.40	0.50	2.00	None	-	Yes	None	1.00	None
Craig County	0.177	0.58	0.50	1.65	0.33	1.10	0.33	1.10	None	None	1.00	None
Botetourt County	0.134	0.54	0.20	0.80	0.30	1.20	0.30	1.20	None	Yes	None	None
Rockbridge County	0.250	0.99	0.08	1/	0.08	1/	Yes 1/	1/	None	None	1.00	None
Covington City	0.265	1.02	0.10	0.39	0.40	1.54	None	-	Yes	None	1.00	None
Clifton Forge City	0.373	1.17	0.40	1.30	0.40	1.30	None	-	Yes	None	1.00	None
Lexington City	0.250	1.10	0.08	1/	0.08	1/	None	-	Yes	None	1.00	None
Buena Vista City	0.400	1.38	0.20	1/	0.20	1/	None	-	Yes	None	1.00	None
Amherst County	0.200	0.62	0.10	0.31	0.25	0.78	0.20	0.62	Yes	None	None	10.00
Nelson County	0.150	0.75	0.10	0.50	0.40	2.00	0.40	2.00	None	Yes	None	10.00
Albemarle County	0.150	0.88	2/	2/	0.25	1/	None	-	None	Yes	None	10.00
Greene County	0.126	0.47	0.20	0.75	0.20	0.75	1.00	0.90	None	None	None	10.00
Appomattox County	0.300	0.90	2/	2/	0.30	1/	0.30	1/	None	None	None	None
Buckingham County	0.300	0.75	0.30	0.75	0.50	1.25	1.00	1.00	None	None	None	10.00
Fluvanna County	0.186	0.54	0.20	0.54	0.186	0.54	0.50	1.45	None	None	None	5.00
Goochland County	0.230	0.70	2/	2/	2/	2/	0.54	1.52	None	Yes	None	10.00
Cumberland County	0.250	0.90	0.20	0.72	0.20	0.72	1.00	0.30	None	None	None	5.00
Powhatan County	0.330	1.17	0.33	1.17	0.33	1.17	0.33	1.17	None	None	None	7.00

See footnotes at end of table.

Table III-15. Tax assessments for counties and cities, varying years, 1966-1970, James River Basin--Continued

County or City	Real Estate		Machinery & Tools		Personal Property		Merchant Capital		Merchant License	Utility	Sales (percent)	Vehicle License
	Assessment Ratio	True Tax per $100	Assessment Ratio	True Tax per $100	Assessment Ratio	True Tax per $100	Assessment Ratio	True Tax per $100				
Amelia County	0.220	$ 0.66	0.30	$ 0.90	0.30	$ 0.90	1.00	$ 0.40	None	None	None	$ 10.00
Prince Edward County	0.200	0.50	0.20	0.50	0.20	0.50	1.00	0.70	None	None	None	None
Nottoway County	0.240	0.86	0.25	0.90	0.25	0.90	0.30	1/	None	None	None	None
Lynchburg City	0.500	1.50	0.30	0.90	2/	2/	0.30	1/	Yes	Yes	None	10.00
Henrico County	0.330	0.96	2/	2/	2/	2/	None	None	Yes	None	None	None
Chesterfield County	0.303	0.94	0.35	0.23	2/	2/	None	None	None	None	None	Yes1/
New Kent County	0.200	0.85	0.15	0.64	0.20	0.85	1.00	3.10	None	None	None	10.00
Charles City County	0.200	0.85	2/	2/	0.40	1.70	0.40	1.70	None	Yes	None	10.00
Prince George County	0.300	0.87	1.00	1.00	0.60	1.74	1.00	1.00	None	Yes	None	None
James City County	0.300	1.26	0.10	0.42	1.00	4.20	1.00	4.20	None	None	None	10.00
Surry County	0.200	0.40	0.50	1.00	0.50	1.00	0.50	1.00	None	None	None	10.00
Isle of Wight	0.245	0.74	0.10	0.30	1.00	3.00	2/	2/	None	None	None	5.00
Richmond City	0.899	1.65	2/	2/	2/	2/	None	None	Yes	Yes	None	None
Hopewell City	0.450	1.44	0.13	0.50	None	None	None	None	Yes	None	None	10.00
Colonial Heights City	0.956	1.24	0.40	0.52	1.00	2.50	None	None	Yes	Yes	None	Yes1/
Petersburg City	0.428	0.90	2/	2/	2/	2/	None	None	None	None	1.00	None
Williamsburg City	0.400	1.04	0.33	1.16	0.33	1.16	None	None	Yes	Yes	None	10.00

1/ Not reported.

2/ Use varying formula.

Source: Economic Data Summaries for Counties and Cities in the James River Basin, Virginia Division of State Planning and Community Affairs, Richmond, Virginia. Most of the cities and counties have other minor tax assessments.

Table III-16. Land use[1/], by subarea, by year, James River Basin

Subarea	Year	Cropland	Pasture	Forest Land	Other	Independent: Cities and Urban Areas	Water Area	Total Land and Water Areas[2/]
					Acres			
Subarea 1	1967	130,616	240,778	1,411,660	33,981	30,186	7,623	1,854,844
	1980	99,300	211,000	1,458,700	37,221	41,000	7,623	1,854,844
	2000	54,200	179,100	1,518,500	39,421	56,000	7,623	1,854,844
	2020	37,000	150,000	1,548,000	42,221	70,000	7,623	1,854,844
Subarea 2	1967	426,550	372,998	2,205,185	75,498	72,545	38,543	3,191,319
	1980	269,000	279,600	2,359,700	140,076	104,400	38,543	3,191,319
	2000	169,900	212,100	2,459,100	171,876	139,800	38,543	3.191,319
	2020	111,000	169,000	2,484,000	208,776	180,000	38,543	3,191,319
Subarea 3	1967	220,332	31,006	907,503	72,521	147,191	93,943	1,472,496
	1980	164,600	24,200	901,600	102,853	185,300	93,943	1,472,496
	2000	137,500	18,200	851,000	118,553	253,300	93,943	1,472,496
	2020	114,000	15,000	757,000	156,553	336,000	93,943	1,472,496
Basin Total								
	1967	777,498	644,782	4,524,348	182,000	249,922	140,109	6,518,659[2/]
	1980	532,900	514,800	4,720,000	280,150	330,700	140,109	6,518,659
	2000	361,600	409,400	4,828,600	329,850	449,100	140,109	6,518,659
	2020	262,000	334,000	4,789,000	407,550	586,000	140,109	6,518,659

1/ Definitions of the various land uses and water areas can be found in Appendix C.

2/ This total represents the total acres in the James River Basin generalized to county boundaries. It is 1.18 percent larger than the 6,442,390 acres in the Basin using hydrologic boundaries.

Source: 1967 CNI and projection methodology described in text.

forest lands with 279,000 acres.

The enormous impacts of technological adaptation have changed the production mix of agriculture in the Basin and throughout the Nation. Increased cropland is not essential to increased crop production. More production from less land is the norm in the Basin and the Nation and is the underlying cause of expected decreases in cropland. This fact, in combination with the increased economic importance of forage-consuming livestock production, has shifted land out of crop production and into pasture.

The data indicates that of the 826,000 acres which are expected to shift out of agricultural usage by the year 2020, 41 percent will be bid to higher uses in urban areas. Land which will revert to forest land accounts for 32 percent or 265,000 acres of the shifted agricultural lands. "Other" land will be increased by 225,000 acres, or 27 percent.

The greatest pressure of urbanization is expected to occur in Subarea 2. Additional 189,000 acres will shift from other uses to urban uses. Forest land is expected to decrease by 150,000 acres in this subarea.

Agricultural Economics

The structure of agriculture has been changing in the James River Basin. However, Basin changes have only paralleled changes taking place in the agricultural economy of the entire Nation. The agricultural characteristics were developed to cover the historic years 1949 through 1969 and the projection years 1980, 2000, and 2020. The present status of farm characteristics is indicated primarily in terms of 1969 data. The primary source of data was the Census of Agriculture.

Number and Size of Farms

The James River Basin has experienced much the same trend as the national decline in farm numbers and consequent rise in average farm size. The number of farms has declined by nearly three-fifths from 26,436 in 1949 to 10,564 in 1969 (Table III-17). In 1969, there were 3,186 farms with sales greater than $5,000. Ten percent of the farms had sales exceeding $20,000 and 469 farms had sales exceeding $40,000.

The number of "other farms" decreased in absolute numbers from 9,242 in 1949 to 4,646 in 1969. In 1949 "other farms" were 35 percent of the total number of farms. By 1969 they had risen to 44 percent of total farms. The percentage of

Table III-17. Farms classed by value of products sold, 1959, 1964 and 1969, James River Basin

County	Class I 1/			Class II 2/			Class III 3/			Class IV 4/		
	1959	1964	1969	1959	1964	1969	1959	1964	1969	1959	1964	1969
Highland County	3	8	15	8	10	24	29	22	31	45	43	60
Bath County	2	3	5	10	4	11	37	17	21	32	18	25
Alleghany County	6	0	0	1	4	3	12	9	14	15	15	18
Craig County	2	0	0	0	1	3	5	9	17	45	25	35
Botetourt County	3	20	26	33	29	41	63	37	35	87	43	45
Rockbridge County	8	17	23	11	21	29	74	42	55	97	68	122
Subarea 1	24	48	69	63	69	111	220	130	173	321	212	305
Albemarle County	33	28	40	39	31	42	99	50	67	103	81	110
Amelia County	24	15	32	44	41	31	33	59	52	89	107	81
Amherst County	4	3	6	5	7	10	20	18	30	36	40	52
Appomattox County	0	2	8	16	8	13	47	31	24	82	65	76
Buckingham County	2	7	26	36	19	18	40	47	39	53	63	70
Cumberland County	5	18	24	17	19	27	47	27	24	75	53	60
Fluvanna County	2	4	8	13	4	4	22	13	19	23	26	32
Goochland County	1	7	7	12	5	12	4	21	29	37	31	35
Greene County	13	10	10	6	8	9	10	7	6	15	15	22
Nelson County	6	6	11	24	14	11	23	24	39	45	33	40
Nottoway County	11	15	17	22	28	34	76	62	49	97	99	70
Powhatan County	8	14	21	21	23	22	23	14	16	31	23	13
Prince Edward County	3	16	23	49	24	27	47	40	28	95	86	75
Subarea 2	112	145	233	304	231	260	491	413	422	781	722	736
Charles City County	7	7	13	19	15	15	10	6	6	10	12	4
Chesterfield County	4	11	10	11	11	6	36	26	16	61	39	23
Henrico County	37	20	20	38	18	8	32	22	22	36	33	16
Isle of Wight County	2	29	51	43	73	86	121	113	107	165	95	81
James City County	11	7	12	21	10	11	0	6	9	16	13	9
New Kent County	1	3	10	22	13	11	21	15	9	17	15	14
Prince George County	8	7	14	17	24	28	35	39	34	45	63	59
Surry County	0	11	37	35	38	50	53	68	50	95	77	48
Subarea 3	70	95	167	206	202	215	308	295	253	445	347	254
Basin Totals	206	288	469	573	502	586	1,019	838	848	1,547	1,281	1,295

1/ Class I: Sales $40,000 or greater.
2./ Class II: $20,000 to $39,999.
3/ Class III: $10,000 to $19,999.
4/ Class IV: $5,000 to $9,999.

Continued

Table III-17. Farms classed by value of products sold, 1959, 1964 and 1969, James River Basin--Continued

County	Class V and VI 5/			Other Farms 6/			Class I-IV		
	1959	1964	1969	1959	1964	1969	1959	1964	1969
Highland County	163	133	130	252	216	201	85	83	130
Bath County	75	72	58	186	95	69	81	42	62
Alleghany County	45	74	61	377	197	152	34	28	35
Craig County	85	98	63	180	201	147	52	29	55
Botetourt County	167	163	162	490	396	322	186	129	147
Rockbridge County	280	269	213	605	519	338	190	148	229
Subarea 1	815	809	687	2,090	1,624	1,222	628	459	658
Albemarle County	247	278	168	746	478	339	274	190	259
Amelia County	302	218	168	381	256	262	190	222	196
Amherst County	240	256	155	607	475	240	65	68	98
Appomattox County	281	251	173	386	281	219	145	106	121
Buckingham County	210	224	130	482	332	262	131	136	153
Cumberland County	195	180	127	390	274	178	144	117	135
Fluvanna County	96	98	77	387	257	228	60	47	63
Goochland County	116	117	92	386	291	199	54	64	83
Greene County	85	136	86	370	261	104	44	40	37
Nelson County	152	224	120	530	392	206	98	77	101
Nottoway County	195	140	105	305	215	187	206	204	170
Powhatan County	96	59	47	223	171	101	83	74	72
Prince Edward County	335	277	204	291	299	253	194	166	153
Subarea 2	2,550	2,458	1,652	5,484	3,982	2,778	1,688	1,511	1,641
Charles City County	6	18	10	112	49	27	46	40	36
Chesterfield County	81	111	59	339	219	125	112	87	55
Henrico County	40	63	39	311	181	129	143	93	66
Isle of Wight County	135	122	114	140	100	108	331	310	325
James City County	25	22	18	70	38	30	48	36	41
New Kent County	27	29	19	100	72	39	61	46	44
Prince George County	115	99	95	182	169	96	105	133	135
Surry County	180	113	77	181	89	85	183	194	185
Subarea 3	659	577	431	1,435	917	639	1,029	939	887
Basin Totals	4,024	3,844	2.770	9,009	6,523	4,646	3,345	2,909	3,186

5/ Class V & VI: Sales less than $4,999.
6/ Other farms include part time, part retirement and abnormal forms.
Source: Census of Agriculture.

"other farms" can be expected to remain high as livestock production displaces cash cropping and as employment opportunities become more attractive in the growing urban areas, particularly within Subarea 3. By maintaining a part-time farm and holding a full-time job, the labor factor in rural areas will be able to reach levels of greater resource efficiency. Part-time beef operations have complemented the trend toward increased off-farm employment. Within limits, this type of farming operation does not require the operator to forego off-farm employment opportunity as a cost of expansion.

Land in farms in the Basin had decreased from 3,450,122 acres in 1949 to 2,232,122 acres in 1969, a 35 percent decrease. The decreases for the same period in Subareas 1, 2, and 3 were 27, 37 and 41 percent, respectively. The acres of land in farms decreased 6,087 acres annually during the 1949-69 period. The corresponding rate of decrease for Subarea 3 was 13,510 acres.

Although the number of farms has decreased, there has been a commensurate increase in the average size of farms as evidenced by Table III-18. The national pattern has been the same. However, the average farm size for most counties is still below the United States' average farm size of 352 acres. The average size of Basin farms is expected to continue to become less labor intensive.

Table III-18. Farm characteristics, by subarea, by year, James River Basin

Characteristic	Year	Subarea 1	Subarea 2	Subarea 3	James River Basin
Land in Farms (acres)	1949	818,710	1,972,574	658,838	3,450,122
	1964	644,964	1,497,117	449,636	2,591,717
	1969	601,442	1,242,629	388,642	2,232,713
Average Size of Farms (acres)	1949	174.2	129.4	116.6	140.1
	1964	242.9	186.4	211.1	213.5
	1969	233.7	202.9	202.5	210.3
Value of Land & Buildings Per Farm (dollars)	1949	9,186	7,142	10,442	8,923
	1964	22,882	25,127	51,708	33,239
	1969	41,311	47,386	83,030	52,380

Source: U.S. Census of Agriculture.

Value of Land and Buildings

A marked increase in the value of land and buildings per farm in all of the subareas since 1949 is noted (Table III-18). Subareas 1, 2, and 3 experienced respective gains in value of 450, 663, and 795 percent. The gain for the entire Basin was 587 percent due to the influence of Subarea 3. Subarea 3 is expected to maintain its greater rate of increase due to increased land value associated with urbanization and the related shift in the demand for land. The value of land and buildings in Subareas 1 and 2 is more closely tied to the degree of farm related capitalization, although the eastern portion of Subarea 2 is also experiencing urbanization pressures.

Value of Agricultural Production[1/]

The value of all farm products sold in 1969 was $83,327,000, an increase of 68 percent over the 1949 value. Subarea 2 was the sales leader with $42 million. All subareas exhibited a rise in receipts from 1949 through 1959, but 1964 receipts fell short of record 1959 figures in all subareas except in Subarea 3. All subareas again showed an increase from 1964 to 1969.

The returns from sales of all crops totaled $29,578,650 in 1969. The average return over the 20-year period since 1949 was roughly $25 million or $17 million less than the average for all livestock and poultry products sold in the same period.

Field crops accounted for $21,045,508 or 73 percent of total value of crop production in 1964, ranking them as the number two agricultural revenue producer.[2/] In 1964, they returned $20,126,123 less than livestock and livestock products sales, which was the leader in agricultural revenues. This gap can be expected to increase; i.e., sales of livestock and livestock products can be expected to increase at a faster rate than sales of field crops.

Fruit and nut sales accounted for the second largest portion of crop sales. Average sales for the 15-year period were $3,058,320. Sales in 1964 were $2,688,970 nearly $369,000 below the average.

1/ See Appendix B, Table 9 for data presented in this section.

2/ Detailed data for 1969 is not readily available for all farms (only farms with sales greater than $2500) and therefore, is not comparable with most of the data presented in the Appendix tables.

Vegetable sales were lower than fruit and nut sales. Average sales since 1949 were $343,756. Sales have shown a decrease of 66 percent in Subarea 1 and a 19 percent decrease in Subarea 2 since 1949. Subarea 3, however, has shown a 74 percent increase during the same period. This reflects the greater demand and profitability for this type of production in urban areas.

Forest and horticultural specialty product sales[1/] were $4,608,770 in 1964, a 50 percent gain over sales of $3,082,712 in 1949. The bulk of these products sales occurred in Subareas 2 and 3.

Sales of all livestock and livestock products were greater than sales from any other type of agricultural activity. Returns averaged $41,535,952 per year over the 20-year period following the 1949 Census. Sales in 1969 were $58,738,409, $30,915,699 greater than in 1949.

Dairy products sales remained relatively constant from 1949 to 1964 in all subareas except Subarea 2, where they went from $4,587,205 in 1949 to $8,676,113 in 1964. Total dairy products sold were $12,972,776 in 1964, which represents an increase of $4,593,720 over 1949 sales. Dairy products sales ranked third in specific categories behind other livestock products sold and field crops sold.

Poultry and poultry products sold represent the fourth largest category of agricultural enterprises. Sales in 1964 were $10,774,817, an increase of $4,921,115 over the 1949 figure.

Other livestock and livestock products sold represents the second largest revenue earner, superseded only by returns from field crops. Average returns over the 15-year period were $16,647,363. Returns in 1964 were $17,285,247 which was $637,844 above the average.

Trends in Agricultural Production

Crops[2/] Since 1949, hay crops have maintained their position as the most important type of production in terms of acres. A shift of 74,147 acres out of production occurred, but relative to percentage losses for other crops, the 32 percent reduction is small. Acres devoted to hay production totaled 160,296 in 1969. Although hay acreages have decreased, the increased use of fertilizer and lime, as well as better management practices, have raised yields of the grasses so that fewer acres will support larger herds of livestock.

1/ Does not include products cut from industrial and National forest lands.

2/ See Appendix B, Table 10 for data presented in this section.

Second only to the hay group in importance during the 20-year interval since 1949 was corn for grain. In 1969, 76,570 acres were in corn for grain production. This represented a loss of 77,563 acres, or 50 percent since 1949. Increased productivity due to better soils management, hybrids and planting-harvesting technology in combination with the general transition of agriculture from cash cropping to livestock production has decreased the acreage devoted to production of corn for grain. However, an offsetting rise of 20,908 acres in corn harvested for silage occurred during the same period. This 264 percent increase reflects the shift to livestock and supporting activities, such as corn silage, which has taken place. The largest increase in corn silage occurred in Subarea 2 which also experienced the greatest decrease in corn for grain acreages.

Sorghum raised for grain or seed represents a relatively minor crop enterprise, utilizing only 1,300 acres in 1949 and 1,877 acres in 1969; an increase of 577 acres of 44 percent. Acreage of sorghum for silage has increased slightly since 1949, but also remained relatively unimportant at the level of 2,318 acres in 1969.

Soybeans is a crop which has increased in importance throughout the southern and midwestern areas of the country since 1949. Basin statistics also reflect this trend. Production occurred on 51,392 acres in 1969, reflecting an increase of 206 percent over the 1949 acreage of 16,794. Subarea 3 accounted for all but 12,785 acres.

Peanuts for picking or threshing has experienced a decline of 9,066 acres since 1949. Of the 27,515 acres in peanut production in 1969, practically all were grown in Subarea 3.

The acreage of small grains harvested decreased 41 percent from 110,125 acres in 1949 to 65,171 acres in 1964. That represents an average annual decrease of nearly 3,000 acres.

The importance of other field crops has slipped since 1949 with 7,099 acres shifting out of production. Other field crops were grown on 8,658 acres in 1964.

Acres devoted to the production of saleable vegetables decreased 1,584 from a high of 2,952 acres in 1954 to 1,368 acres in 1969. Three quarters of all production occurred in the more urbanized Subarea 3. Increased demand for fresh vegetables is expected to stabilize the number of acres devoted to this commodity. Increased irrigation of vegetable acres would cause significant increases in the production of vegetables. It also might be expected that acres devoted to vegetable production will more easily resist the encroachment of the suburban community because they produce higher per unit value

crops than do acres devoted to field, hay, and pasture crops.

Land in orchards decreased from 26,676 acres in 1949 to 8,195 acres in 1969, a 69 percent decrease. Two-thirds of the land in orchards occurs in Subarea 2.

Livestock and Poultry.[1/] The number of milk cows on farms decreased from 71,042 in 1949 to 28,814 in 1969. By the year 2020, this number is expected to decrease to 14,000.

Cattle and calves on farms numbered 230,595 in 1969, an increase of 82,377 over 1949. By the year 2020, this number is expected to climb to 320,000. This reflects a continued increase in the popularity of beef cattle.

The number of hogs and pigs on farms is expected to decrease to 50,000 or less by the year 2000. They numbered 118,325 in 1969, down from 164,072 in 1949.

The number of sheep and lambs will continue to decrease, numbering 35,000 in 1980 and 15,000 in 2000. They decreased from 79,477 in 1949 to 48,454 in 1969.

Chickens, three months old and over, numbered 758,054 in 1969, a decrease from the 1,256,926 registered in 1949. This number can be expected to decrease to 600,000 or less by 2020.

Demand for Crop and Livestock Products

In order to measure the adequacy of the resource base for production of agricultural products in the future, some reasonable share of national food and fiber projected production is needed. Ideally, such an allocation of future demand to specific regions should be based on the relative efficiencies of competing areas in achieving projected agricultural needs at minimum cost or with the lowest expenditure of economic resources.

The level of production which must be achieved in order to support the projected population or to maintain projected relative positions in the Nation's agriculture determines the Basin demand. The Basin can be analyzed with this projection base with respect to needs for development of the land and water resources for agricultural purposes. Further, this demand level provides a benchmark to which productive capacity can be compared. Such a comparison makes possible some tentative conclusions as to the activities needed to achieve this volume of production. If the productive capacity required to produce

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1/ See Appendix B, Table 11 for data presented in this section.

this volume exists, then it indicates the probable future level of production. It is assumed that the future competitive position will be relatively the same as at the present time.

The national projections of food and fiber production were developed through analysis and projection of domestic consumption, industrial use and export-import balances.[1/] Likewise, regional projections were based upon historical national-regional relationships and expected shifts in these relationships. The James River Basin lies within the North Atlantic Water Resource Region. Projections of the demand for agricultural products for the Nation and the North Atlantic Region are presented as Tables III-19 and III-20.[2/]

Projections for the James River Basin were determined using historical shares of production for each crop in each subregion, projections of these shares, and State (Virginia) projections of production levels from OBERS.[3/] First, production of each major crop in each subregion was calculated as a percentage of State production for the agricultural census years of 1949, 1954, 1959, and 1964.[4/] These historical shares of production were then projected to 1980, 2000, and 2020 for each major crop in each subregion. Adjustments were made, if necessary to eliminate negative shares and to weigh recent data more heavily. The subregional shares were then added to obtain historical and projected shares of State production as shown in Table III-21.[5/]

1/ "Preliminary Projections of Economic Activity in the Agricultural, Forestry and Related Economic Sectors of the United States and Its Water Resource Regions, 1980, 2000, and 2020", prepared by the Economic Research Service and Forest Service, United States Department of Agriculture, August, 1967 (Revised March 8, 1968).

2/ The national and regional production projections have been revised (1971-72) by Economic Research Servie, USDA and Bureau of Economic Analysis, U.S. Dept. of Commerce.

3/ OBERS signifies a unified effort of the Office of Business Economic (OBE) and the Economic Research Service (ERS).

4/ Source: <u>1972 OBERS Projections of Regional Economic Activity in the U.S.</u>, U.S. Water Resources Council, Washington, D. C.

5/ When comparable 1969 Census of Agriculture numbers become available the percentage shares should be computed and used to verify and/or recompute the projected shares of production for the Basin.

Table III-19. Production of agricultural commodities: United States, 1959-61 average, with projections to 1980, 2000, and 2020[1/]

Commodity	Unit	1959-61	1980	2000	2020
			Projections		
		Thousands			
Feed Grains(corn equiv)	Tons	145,128	199,683	259,571	339,956
Corn	"	106,010	146,640	193,813	258,222
Oats	"	17,167	18,471	17,176	12,662
Barley	"	9,995	12,624	12,866	12,035
Sorghum	"	15,445	26,377	40,759	62,640
Food Crops					
Wheat	Bu.	1,237,700	1,889,600	2,192,200	2,618,600
Rye	"	27,868	40,732	53,893	72,518
Rice (rough)	Cwt.	54,145	84,130	96,470	113,850
Peanuts (farm stock)	Lbs.	1,705,500	2,519,000	3,455,000	3,774,000
Sugar (raw)	Tons	3,290	7,619	12,497	19,357
Dry beans	Cwt.	19,048	23,450	30,980	41,580
Dry peas	"	3,927	5,300	6.100	7,220
Potatoes	"	265,609	328,876	450,136	627,396
Sweet potatoes	"	16,508	18,052	24,882	34,492
Fruits and Vegetables					
Citrus fruits	Tons	8,028	11,479	15,446	21,026
Non-citrus fruits	"	9,952	13,123	18,887	26,995
Vegetables	Cwt.	403,902	642,235	881,055	1,217,135
Tree nuts (shelled)	Lbs.	170,000	154,000	303,000	513,000
Fiber and Misc. Crops					
Cotton	Lbs.	7,191,300	8,429,000	10,335,000	13,016,000
Flaxseed	Bu.	24,605	22,518	29,161	38,500
Soybeans	Bu.	589,257	1,305,467	1,640,933	2,116,367
Tobacco	Lbs.	1,934,200	2,225,000	2,932,000	3,926,000
Livestock and Products					
Beef and veal	Lbs.	28,898,500	47,451,000	66,580,000	93,537,000
Pork	"	20,220,400	27,056,000	37,352,000	51,830,000
Lamb and mutton	"	1,683,000	1,700,000	2,378,000	3,331,000
Farm chickens	"	1,251,700	1,456,000	2,005,000	2,779,000
Turkeys	"	1,600,900	3,559,000	4,888,000	6,760,000
Eggs	No.	62,302,000	75,528,000	104,065,000	144,289,000
Milk	Lbs.	123,460,700	145,089,000	198,719,000	274,269,000
Broilers	Lbs.	6,207,100	10,702,000	14,608,000	20,111,000

1/ Exclude Alaska and Hawaii.

Source: "Preliminary Projections of Economic Activity in the Agricultural, Forest and Related Economic Sectors of the U.S. and Its Water Resource Regions, 1980, 2000, and 2020," prepared by Economic Research Service and Forest Service, USDA, Aug., 1967 (Revised March 8, 1968), Appendix Table 1.

Table III-20. Preliminary projections of production of major agricultural product groups, 1980, 2000 and 2020, North Atlantic Water Resource Region

Commodity Group[2/]	1980	Projections[1/] 2000	2020
		Index	
Feed Crops	113	126	137
Feed Grains	115	xxx	xxx
Hay and Forage	111	xxx	xxx
Food Crops	133	182	253
Food Grains	104	xxx	xxx
Vegetables, Fruits, Sugar	144	xxx	xxx
Other Food Crops	122	xxx	xxx
Oil and Fiber Crops	139	180	236
Oil Crops	184	xxx	xxx
Cotton	---	xxx	xxx
Tobacco	102	xxx	xxx
Livestock and Products	120	165	228
Meat Animals	126	xxx	xxx
Milk	124	xxx	xxx
Poultry Products	177	xxx	xxx

1/ Projections are indexes of physical volume, 1959-61 = 100.

2./ Items included in each commodity group are as follows:
Feed Grains: corn, oats, barley, sorghum grain;
Hay and Forage: hay silage, straw stover, pulp;
Food Grains: wheat, rye, rice;
Vegetables, Fruits, Sugar: vegetables, citrus and non-citrus fruits, nuts, sugar cane, sugar beets;
Other Food Crops: potatoes, sweet potatoes, dry beans, dry peas;
Oil Crops: soybeans, peanuts, flaxseed;
Meat Animals: beef, veal, pork, lamb, mutton;
Poultry Products: farm chickens, turkeys, eggs, broilers.

Source: "Preliminary Projection of Economic Activity in the Agricultural, Forest and Related Economic Sectors of the U.S. and Its Water Resource Regions, 1980, 2000 and 2020," Appendix Table 2, prepared by Economic Research Service and Forest Service, USDA, August, 1967 (Revised March 8, 1968).

Table III-21. Historical and projected share of agricultural production, James River Basin

	Unit of Sale	Subregion Share of Virginia 1949	1954	1959	1964	1980	2000	2020
					Percent			
Wheat	Bu.	18.03	20.46	19.47	19.38	22.15	26.02	30.00
Rye	Bu.	14.37	15.02	14.18	18.18	20.19	25.40	30.57
Corn for grain	Bu.	17.36	18.42	18.16	18.11	18.91	21.28	24.08
Silage	Tons	14.81	15.43	18.86	22.66	30.26	41.42	52.57
Sorghum grain	Bu.	8.57	16.15	22.28	18.42	32.41	47.00	61.59
Oats	Bu.	23.52	22.86	22.71	20.65	18.49	15.06	14.93
Barley	Bu.	19.96	16.73	19.41	18.75	20.27	25.02	29.83
Fruits & nuts	Tons	24.90	19.22	11.59	15.33	11.47	6.99	3.49
Vegetables sold	Cwt.	3.33	3.27	4.04	3.60	4.49	5.63	6.95
Hay	Tons	21.94	20.83	21.81	20.20	19.29	18.33	20.03
Soybeans	Bu.	13.31	13.35	16.36	15.01	18.23	21.56	24.89
Peanuts	Lbs.	31.28	30.02	28.48	26.89	22.55	16.66	10.76
Cotton	Lbs.	2.41	1.80	1.45	1.06	0.26	0.11	0.06
Tobacco	Lbs.	10.06	9.30	9.87	4.62	1.39	1.29	1.55
Irish potatoes	Cwt.	4.65	6.26	3.07	1.53	0.30	0.15	0.15
Sweet potatoes	Cwt.	8.35	4.26	33.53	1.91	0.36	0.16	0.11
Cattle & Calves	Lbs.	18.35	19.18	18.72	18.78	19.13	19.47	19.80
Hogs & Pigs	Lbs.	20.63	22.98	21.53	21.50	22.18	22.65	24.11
Sheep & Lambs	Lbs.	17.50	19.72	20.09	19.44	21.98	24.45	26.92
Chicken	Lbs.	16.91	17.29	25.15	15.37	15.94	14.83	13.73
Broilers	Lbs.	N.R.1/	19.20	25.85	15.28	10.90	7.78	7.24
Turkeys	Lbs.	5.72	13.74	8.95	10.23	14.40	18.89	23.39
Eggs	No.	19.78	20.59	17.98	18.58	16.44	13.95	11.47
Whole Milk	Lbs.	16.77	16.26	16.92	15.42	14.82	13.96	14.91

1/ None reported.

Source: Historical shares computed from Census of Agriculture. Projected shares computed using linear regression with adjustments where necessary.

Projected production of major crops in Virginia is shown in Table III-22. These were obtained from the new OBERS projections and are subject to minor change. The numbers reflect Virginia's share of national production of the crops shown.

The projected Virginia production quantities were then multiplied by the Basin shares to obtain the physical quantities of production for each crop expected in the Basin (Table III-23). It must be remembered that these quantities may not be consistent; i.e., other production areas of Virginia were not considered and therefore, expected shifts of production between areas within Virginia have not been accounted for.

One check for consistency was performed. The projected quantities of production shown in Table III-23 were divided by yield per acre projections supplied by OBERS to determine the amount of land required to produce the projected quantities. Table III-24 presents the results of the comparison. As we can see, there are no problems in 1980. But in 2000 and 2020 the acres of cropland which are projected to be available for production fall short of the number of acres needed to meet production specified in Table III-23.

Forest Economics

Extent and Utilization: Kind, Volume

Forest lands occupy 68.4 percent of the Basin, or 4.4 million acres, with predominantly oak-hickory cover type. Forest land ownership consists of 73 percent private, 16 percent public and 11 percent industry. The George Washington and Jefferson National Forests occupy 13 percent of the total forest land. Three percent is held by the National Park Service and other public agencies. Timber volumes are fairly well distributed by ownerships. Only about 30 percent of the total standing volume is softwood. Currently, the growth of all species exceeds the harvest by 31 percent. The timber inventory volume is slightly more than one-half the amount which the area is capable of supporting. About one-half of the pulpwood volume harvest is softwood. About one-third of the total volume harvested is sawtimber, of which more than one-half is hardwood. The major forest types and relative area occupied by each are:

Forest Types	Acres (Millions)	Percent
Oak-Hickory	2.92	63
Oak-Pine	0.70	15
Virginia Pine	0.40	9
Loblolly Pine	0.30	7
Other Hardwoods	0.01	3
Shortleaf Pine	0.01	2
Other Softwoods	0.06	1
	4.40	100

Table III-22. Projected production of major crops, Virginia, 1980, 2000 and 2020

	Unit of Sale	Subregion Share of Virginia		
		1980	2000	2020
	(1,000's)			
Wheat	Bu.	4,269.3	2,952.3	1,957.7
Rye	Bu.	531.4	615.8	684.8
Corn for grain	Bu.	26,260.8	16,514.0	10,489.0
Silage	Tons	3,287.3	4,619.1	6,043.8
Sorghum grain	Bu.	326.4	0	0
Oats	Bu.	2,338.4	2,232.3	2,147.6
Barley	Bu.	7,274.8	10,004.0	12,461.8
Fruits & Nuts	Tons	194.7	188.4	190.5
Vegetables Sold	Cwt.	3,014.5	2,210.0	1,633.1
Hay	Tons	1,413.8	1,392.1	1,371.7
Soybeans	Bu.	10,307.2	9,935.6	9,295.5
Peanuts	Lbs.	388,702.4	421,513.8	443,666.5
Cotton	Lbs.	1,036.2	316.6	135.8
Tobacco	Lbs.	132,629.1	141,508.9	148,469.8
Irish potatoes	Cwt.	2,960.6	2,431.4	1,978.3
Sweet potatoes	Cwt.	1,661.4	1,834.6	2,374.7
Cattle & Calves	Lbs.	514,664.6	643,716.6	805,955.7
Hogs & Pigs	Lbs.	160,928.5	140,885.3	122,769.1
Sheep & Lambs	Lbs.	11,621.2	12,648.8	14,084.0
Chickens	Lbs.	33,464.1	46,373.0	61,108.2
Broilers	Lbs.	104,231.4	34,637.7	11,519.1
Turkeys	Lbs.	95,970.9	103,748.9	109,489.4
Eggs (1,000's)	No.	1,142.4	1,325.7	1,533.0
Whole Milk (1,000's)	Lbs.	1,616.9	1,864.4	2,136.2

Source: 1972 OBERS Projections of Regional Economic Activity in the U.S., Volume 5, States, U.S. Water Resources Council, September 1972.

Table III-23. Projected production of major crops, James River Basin, 1980, 2000 and 2020

	Unit of Sale	Subregion Share of Virginia 1980	2000	2020
	(1,000's)			
Wheat	Bu.	945.6	768.2	587.3
Rye	Bu.	107.3	156.4	209.3
Corn for grain	Bu.	4,965.9	3,514.2	2,525.8
Silage	Tons	994.7	1,913.2	3,177.2
Sorghum grain	Bu.	105.8	0	0
Oats	Bu.	432.4	336.2	320.6
Barley	Bu.	1,474.6	2,503.0	3,717.4
Fruits & Nuts	Tons	22.3	13.2	6.6
Vegetables Sold	Cwt.	135.4	124.2	113.5
Hay	Tons	272.7	255.2	274.8
Soybeans	Bu.	1,879.0	2,142.1	2,313.6
Peanuts	Lbs.	87,652.4	70,224.2	47,738.5
Cotton	Lbs.	2.7	0.3	0.1
Tobacco	Lbs.	1,843.5	1,825.5	2,301.3
Irish potatoes	Cwt.	8.9	3.6	3.0
Sweet potatoes	Cwt.	6.0	2.9	2.6
Cattle & Calves	Lbs.	98,455.3	125,331.6	159,579.2
Hogs & Pigs	Lbs.	35,693.9	31,910.5	29,600.0
Sheep & Lambs	Lbs.	2,554.3	3,092.6	3.791.4
Chickens	Lbs.	5,334.2	6,877.1	8,390.2
Broilers	Lbs.	11,361.2	2,694.8	834.0
Turkeys	Lbs.	13,819.8	19,598.2	25,609.6
Eggs (1,000's)	No.	187.8	184.9	175.8
Whole Milk (1,000's)	Lbs.	239.6	260.3	318.5

Source: Computed by multiplying Basin's share of State production by projected State production.

Table III-24. Comparison of cropland and pasture acreage projections with acres required to produce projected quantities of production, James River Basin

	1980	2000	2020
Acres needed to produce projected quantities shown in Table III-23	455,196	434,693	484,764
Acres of cropland projected shown in Table III-16	533,000	361,700	261,600
Additional acres need to meet production goals specified in Table III-23	0	72,993	223,264
Acres of pasture projected shown in Table III-16	514,800	409,500	334,000
Pasture acres necessary to meet production goals specified in Table III-23	0	72,993	223,264
Acres of pasture remaining for livestock production	514,800	336,507	110,736

The total volume of growing stock in 1965 was 4.1 million cubic feet. Included in the growing stock inventory is almost 10.4 million board feet of sawtimber (Table III-25). About 30 percent of this volume is softwoods, mostly pines; 18 percent is soft textured hardwoods; and 52 percent is hard textured hardwoods. Presently, there is almost two and one-half times as much hardwood growing stock and sawtimber volume as softwood growing stock and sawtimber volume.

The average volume per acre for all ownerships is 12 cords[1/] of growing stock or 2,400 board feet of sawtimber. Average volumes per acre for specific ownerships are as follows: forest industry, 14 cords of growing stock or 2,600 board feet of sawtimber; National forest, 11 cords of growing stock or 2,500 board feet of sawtimber;

1/ One cord is equivalent to 80 cubic feet.

Table III-25. Timber volume on commercial forest land, 1965, James River Basin

Item	Volume			
	Growing Stock		Sawtimber	
	Mil. Cu. Ft.	Percent	Mil. Bd. Ft.	Percent
Softwoods1/	1,119.9	27.5	3,076.9	29.7
Soft Hardwoods2/	730.5	17.9	1,889.2	18.2
Hard Hardwoods3/	2,221.6	54.6	5,395.0	52.1
Total	4,072.0	100.0	10,361.1	100.0

1/ Shortleaf pine, loblolly pine, Virginia pine, pond pine, table-mountain pine, pitch pine, eastern white pine, spruce, hemlock, red cedar.

2/ Box elder, red and silver maple, buckeye, hackberry, loblolly-bay, silverbell, butternut, sweetgum, yellow-popular, cucumber tree, magnolia, sweetbay, water tupelo, blackgum, sycamore, cottonwood, black cherry, willow, basswood and elm.

3/ Sugar maple, birch, hickory, dogwood, persimmon, beech, ash, honey locust, holly, black walnut, mulberry, all commercial oaks, and black locust.

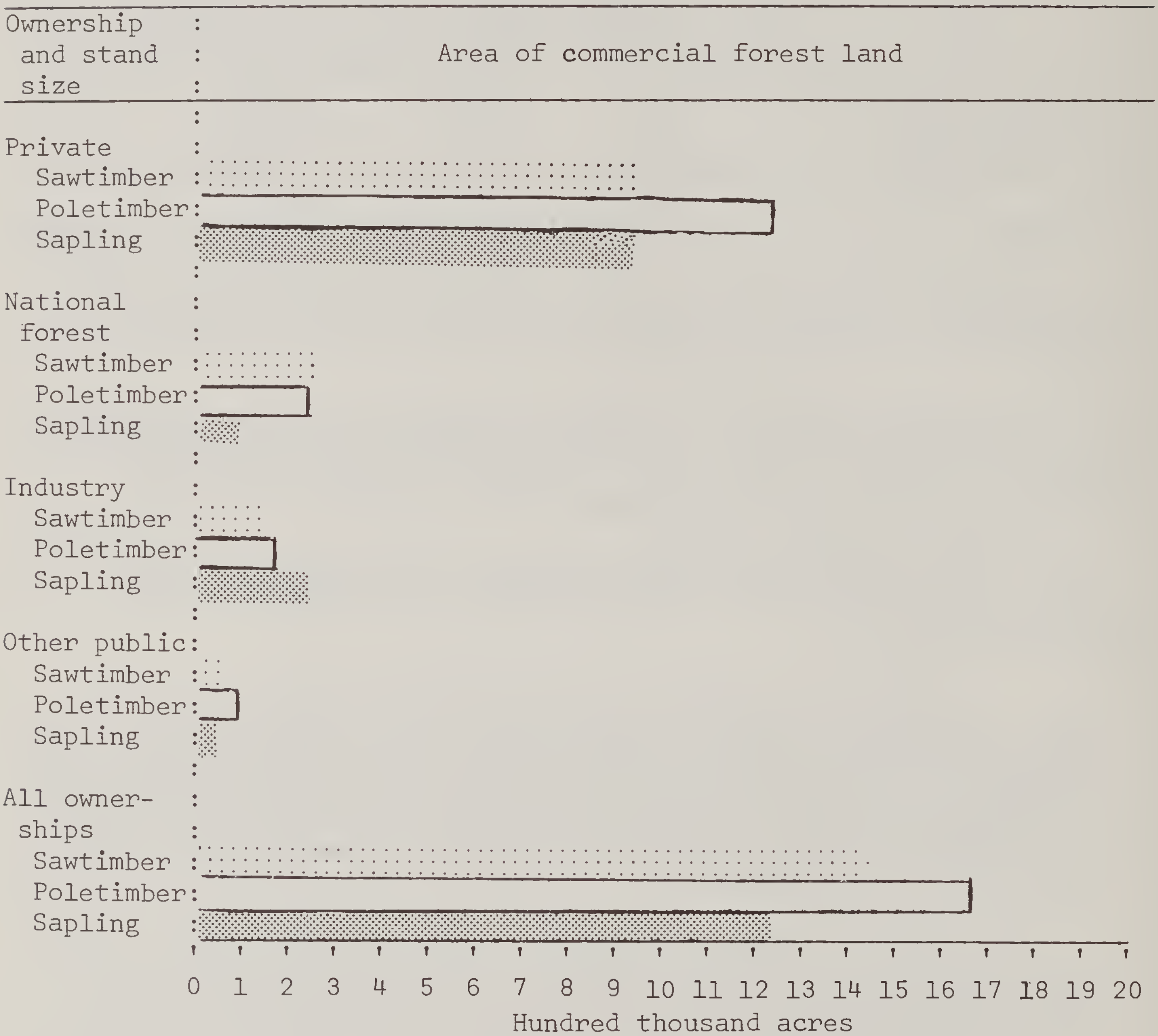
other public, 14 cords of growing stock or 2,800 board feet of sawtimber; private, 11 cords of growing stock or 2,300 board feet of sawtimber. On privately-owned forest, 74 percent contain poletimber and 67 percent contain sawtimber (Graph 2). However, three-fourths of the areas containing sawtimber are stocked with less than 1,500 board feet per acre (Graph 3).

The volume of timber harvested in 1965 is shown in Table III-26. About one-half of the total volume harvested was pulpwood. This volume of pulpwood included 57 percent softwood species which occupy only 19 percent of the forest land area. This heavy demand placed on the softwood resource is causing it to diminish whereas the hardwood resource is increasing. About one-third of the total volume harvested was sawtimber, of which slightly more than one-half was hardwood.

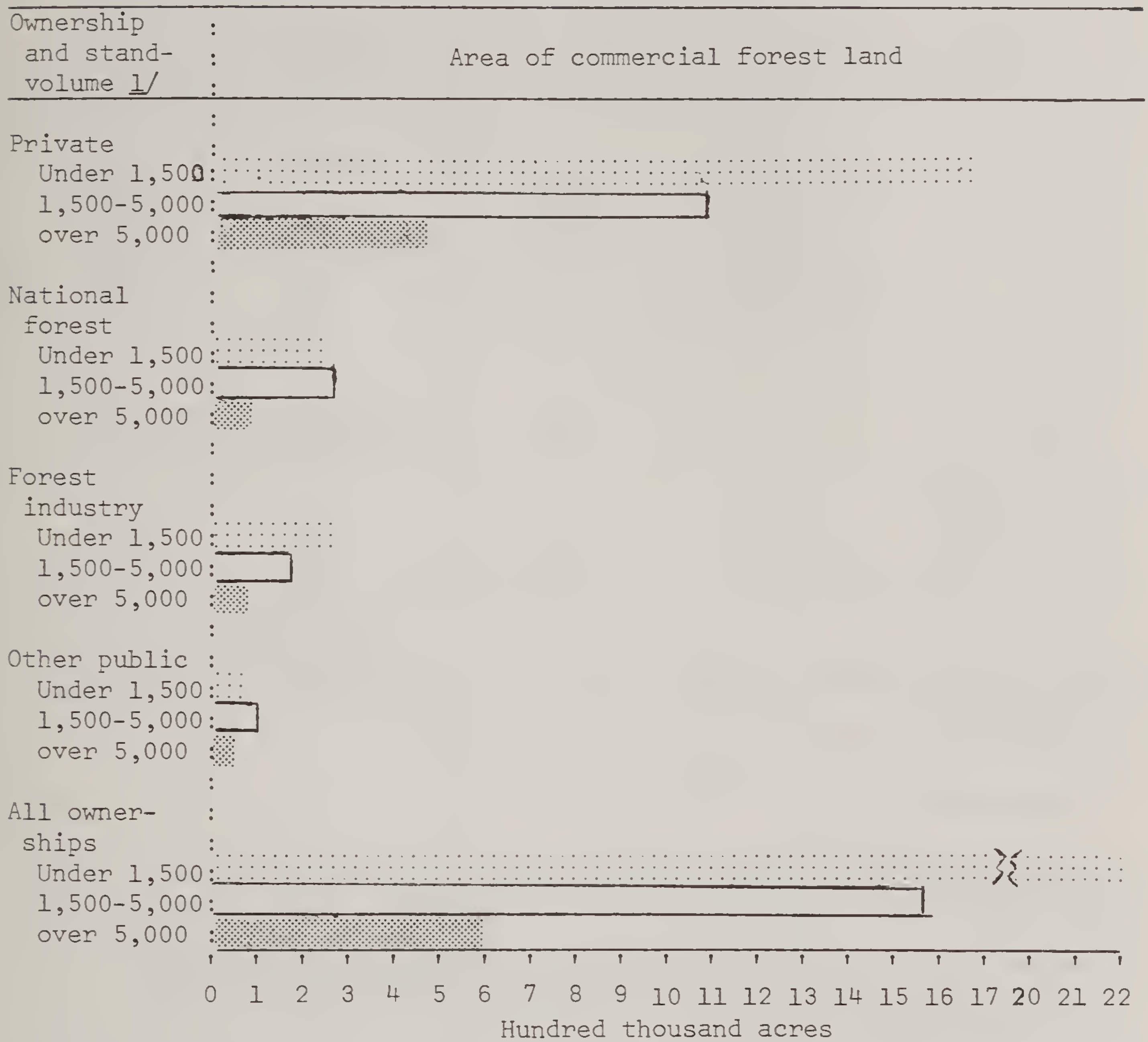
Value of Output

The total estimated value of stumpage harvested in 1965 was 10.6 million dollars (Table III-27). As this volume of timber moved through the production process, its value increased to 22.9 million dollars after delivery to local points, to 87.6 million dollars after

Graph 2. Area of commercial forest land, by ownership and stand size, 1965, James River Basin



Graph 3. Area of commercial forest land, by ownership and stand-volume classes, 1965, James River Basin



1/ Board-feet per acre.

Table III-26. Volume of growing stock cut by product and species groups, 1965, James River Basin

Products and Residues	All Species	Volume Softwood	Hardwood
	thousand cubic feet		
Roundwood products:			
Sawlogs	35,865	16,752	19,113
Veneer logs and bolts	1,585	9	1,576
Pulpwood	52,255	30,111	22,144
Cooperage logs and bolts	1,249	0	1,249
Piling	570	401	169
Poles	282	282	0
Mine timbers	127	10	117
Posts	57	44	13
Other	2,362	992	1,370
Fuelwood	7,035	2,598	4,437
Total	101,387	51,199	50,188
Logging residues:			
Harvesting	11,864	1,158	10,706
Land clearing	4,410	488	3,922
Cultural operations	662	38	624
Total	16,936	1,684	15,252
Total timber harvested in 1965 1/	118,232	52,883	65,440

1/ Represents average annual harvest.

Source: Virginia Forest Survey, 1966.

shipment from primary manufacturing plants, and to $95.8 million after shipment from secondary manufacturing plants. Throughout the production process, value added, or the difference between the cost of goods purchased by an enterprise and the value of the products it sells, creates economic activity providing income and employment to the study area.

In addition to the value of stumpage harvested and subsequent increase in values, Table III-27 shows the value added from harvesting, primary and secondary manufacturing, construction, transportation, and marketing. The value added of those enterprises primarily engaged in timber and timber products was $783.2 million while the value added by enterprise only incidentally involved in timber and timber products was $169.1 million.

For each dollar value of stumpage harvested, there was an increase of almost $10 resulting from changes in form, time, and place. When all economic activity is considered, forest related enterprise adds a multiplier effect of $90 to the value of stumpage harvested.

Table III-27. Estimated values of selected timber and timber-based activities, James River Basin[1/]

Timber based activity	Value in Dollars	
Value of:		
stumpage harvested (on site)[2/]	10,647,000	10,647,000
products harvested[3/]	22,857,700	
shipments from primary manufacturing plants[4/]	87,621,300	
shipments from secondary manufacturing plants[5/]	95,773,700	
Total[6/]	95,773,700	
Value added from:[7/]		
harvesting[8/]		12,210,700
primary manufacturing[9/]		38,850,300
secondary manufacturing[10/]		116,057,000
construction		188,010,700
transportation and marketing[11/]		428,030,000
Total		783,158,700
Value added attributed to timber from:[12/]		
harvesting		12,210,700
primary manufacturing		34,221,600
secondary manufacturing		61,916,100
construction		37,602,100
transportation and marketing		23,143,800
Total		169,094,300
Total		962,900,000

1/ Compiled from data presented in: "The Economic Importance of Timber in the United States", Forest Service Miscellaneous Publication 941, 1963.

2/ 118,300,000 cubic feet @ 9¢ per cubic foot.

3/ Value at local points of delivery.

4/ Value of shipments from sawmills and planning mills; veneer and plywood plants; paper and paperboard mills; and others engaged in primary manufacturing.

5/ Value of shipments from the millwork and prefabricated wood products, industry, the wooden container, the furniture, and paperboard industries.

6/ All items in footnotes 2 through 5 are accumulative.

7/ Value added from industries relying upon timber and timber products from a significant portion of their livelihood.

8/ Includes felling trees and cutting into logs, cutting of miscellaneous products and delivery to local points.

9/ Plants and mills using logs or other roundwood as a source of material.

10/ Establishments engaged in manufacturing beyond the primary stages.

11/ Freight revenues and estimated sales of timber products.

12/ Value added from industries having only incidental business and income generated from timber-based activity.

Forest Industry

An inventory of primary and secondary forest industries by types is presented in Figure 11 and Table III-28. Four of Virginia's seven pulp and paper manufacturing plants are located within the study area, while the other three are located within the sphere of economic influence. Three hardwood plywood plants are located within the study area.

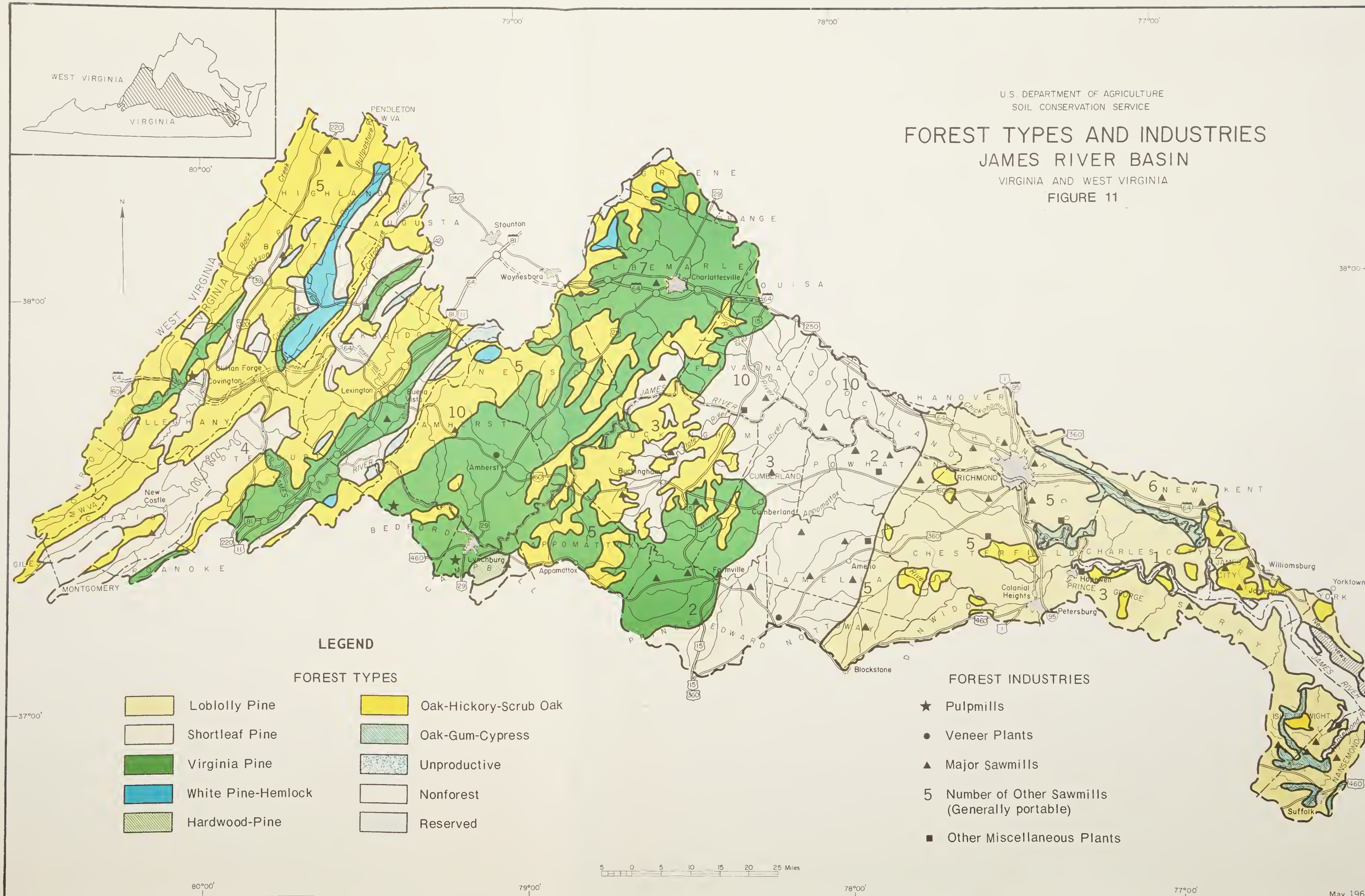
Over 80 percent of all forest products operators are located in the Coastal Plain and Piedmont (Table III-29). Fewer plants and timber markets are found in the mountains where hardwoods prevail, due to poor transportation facilities and less available labor. There are 416 recognized pulpwood operators who buy, harvest, and sell pulpwood. These pulpwood operators, who represent approximately one-half of all forest products operators, harvest slightly more than one-half the total volume of all species in 1966. One-third of all forest products operators harvest the total sawtimber volume, which was 35 percent of the total volume.

Projection of Forest Inventory: Cut and Value

Data tabulated from the Virginia Forest Survey (1966) indicates that the quantity of standing timber and prospective growth is increasing at a faster rate than the harvesting. However, softwood harvesting is already equal to growth. As the continued demand for softwood causes harvesting to increase, the areas being converted from undesirable hardwood to pine production will continue to keep softwood growth and harvesting in balance through 2020. If present levels of forest management continue and demand rises at anticipated rates, the total harvest of all species will equal total growth by 2020.

Present and projected annual growth, available harvest, and inventory of growing stock by species group and time interval is presented in Table III-30. Currently the growth of all species exceeds the harvest by 31 percent. The softwood growth exceeds harvest by two percent. The growth of hardwood species exceeds harvest by 55 percent. The current timber inventory volume is slightly more than one-half the amount which the area is capable of supporting. The potential improvement of the timber inventory, almost one-third greater than the current amount, calls for the application of forest management measures to increase average stand stocking to more desirable levels, increase prospective total growth, and decrease mortality through improved and applied technology by 2020.

Projections based on the assumption that recent levels of management will continue, indicate that growth of both softwoods and hardwoods will keep pace with harvest until about 2020. Present softwood growing stock of 1,120 million cubic feet is expected to increase about six



U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FOREST TYPES AND INDUSTRIES
JAMES RIVER BASIN
VIRGINIA AND WEST VIRGINIA
FIGURE 11
WEST VIRGINIA
VIRGINIA
PENDLETON W VA
HIGHLAND
AUGUSTA
Stounton
Waynesboro
Charlottesville
GREENE
ORANGE
ALBEMARLE
LOUISA
FLUVANNA
GOOCHLAND
HANOVER
HENRICO
RICHMOND
NEW KENT
CHARLES CITY
JAMES CITY
Williamsburg
Yorktown
YORK
BATH
ALLEGHANY
Clifton Forge
Covington
ROCKBRIDGE
Lexington
Buena Vista
NELSON
AMHERST
Amherst
BUCKINGHAM
Buckingham
CUMBERLAND
Cumberland
POWHATAN
CHESTERFIELD
Colonial Heights
Hopewell
PRINCE GEORGE
Petersburg
SURRY
ISLE OF WIGHT
NANSEMOND
Suffolk
DINWIDDIE
NOTTOWAY
AMELIA
Amelia
PRINCE EDWARD
Farmville
APPOMATTOX
Appomattox
CAMPBELL
Lynchburg
BEDFORD
BOTETOURT
New Castle
CRAIG
ROANOKE
MONTGOMERY
GILES
MONROE W VA
JAMES RIVER
Blackstone
LEGEND
FOREST TYPES
Loblolly Pine
Shortleaf Pine
Virginia Pine
White Pine-Hemlock
Hardwood-Pine
Oak-Hickory-Scrub Oak
Oak-Gum-Cypress
Unproductive
Nonforest
Reserved
FOREST INDUSTRIES
Pulpmills
Veneer Plants
Major Sawmills
5 Number of Other Sawmills (Generally portable)
Other Miscellaneous Plants
5 0 5 10 15 20 25 Miles
May 1969
USDA-SCS-HYATTSVILLE, MD. 1970

Table III-28. Forest industries by type and number, James River Basin

Forest Industry	Number
Logging camps and logging contractors	3
Sawmills and planning mills	53
Hardwood dimension and flooring mills	7
Millwork, Veneer, plywood and prefabricated structural wood products	9
Wooden containers	4
Miscellaneous wood products	8
Furniture	26
Paper and allied products	21
Pulp mills	4

Source: Industrial Directory of Virginia Manufacturing and Mining, 1965-1966.

Table III-29. Number of forest products operators, James River Basin

Type of Operator	Physiographic Areas: Coastal Plains	Physiographic Areas: Piedmont and Blue Ridge	Physiographic Areas: Ridges and Valleys
Portable type sawmills 1/	15	94	29
Permanent type sawmills 2/	21	64	20
Pulpwood and excelsior 3/	18	10	0
Pulpwood and excelsior 4/	19	290	79
Stave mills	0	7	0
Veneer yards	9	15	0
Pole and piling	1	3	1
Mine timber	0	0	1
Debarker and chipper	0	0	3
Miscellaneous 5/	21	85	3
Manufacturing mills furniture	0	7	1
Pallets and boxes	0	1	0
Totals	104	576	137

1/ Operators who do not buy logs on their yards.
2/ Operators who buy logs on their yards.
3/ Operators who sometimes sell out of state.
4/ Operators who generally sell within the state.
5/ Includes all other operations; i.e. building supplies, luggage, logging pole and piling, implement and tool handles, hauling, wood preserving, pallets, containers, planning mill, heading mill, sawtimber and pulp, cross ties, veneer, stakes, spools, dry kiln, flooring, fence rail and baskets.

Source: Virginia Division of Forestry, July 1968.

Table III-30. Projected net annual growth, available harvest, and inventory of growing stock by species group, by year[1], James River Basin.

Species Group	Growing Stock 1965	1980	2000	2020
	Million cubic feet			
Softwoods				
Cut	53	58	63	65
Net Growth	54	59	63	65
Inventory	1,120	1,187	1,228	1,226
Hardwoods				
Cut	65	97	135	160
Net Growth	101	124	149	160
Inventory	2,952	3,576	4,091	4,216
All Species				
Cut	118	155	198	225
Net Growth	155	183	212	225
Inventory	4,072	4,763	5,319	5,442

1/ Assumptions:
1. No substantial change in area of commercial forest lands.
2. Forest management will continue at recent levels.
3. Rate of harvest will continue at current trends and will be in balance with growth by 2020.

Source: Virginia Forest Survey, 1966.

percent to 1,187 million cubic feet by 1980 and then diminish to present level by 2020. Present hardwood growing stock of 2,952 million cubic feet is expected to increase 43 percent to 4,216 million cubic feet by 2020.

Appalachian Program

The population of Subregion C in 1960 was 57,085 people. Lynchburg, with a population of 54,790 and Lexington, with a population of 7,537 are just outside the Appalachian Region.[1] The city of Roanoke with a population of 97,110 lies just to the south of Botetourt County.[2]

1/ Development of Water Resources in Appalachia, Main Report, Part II, Sub-Regional Plans A, B, C, Office of Appalachian Studies, Corps of Engineers, Department of the Army, P. O. Box 1159, Cincinnati, Ohio, November, 1969.

2/ Ibid, page II, 5-15.

The urban population in the Subregion (in 1960) was found only in two cities: Covington (11,062) and Clifton Forge (5,268). Over 75 percent of the dominant rural non-farm population was located in Alleghany and Botetourt Counties. Bath, Craig, and Highland Counties contain many small communities and also have a predominant rural non-farm population.1/

The total land area of the Subregion is about 1.47 million acres, of which all but 10,100 acres is presently in agricultural use. The present use of agriculture and forest land is as follows: cropland - 92,300; pasture - 172,500; State and private forest land - 635,000 acres; National forest land - 537,700; and other land - 17,800 acres. Water areas in the Subregion amount to 3,800 acres or about 0.3 percent of the total land area.

1/ Development of Water Resources in Appalachia, Main Report, Part II, Sub-Regional Plans A, B, C, Office of Appalachian Studies, Corps of Engineers, Department of the Army, P. O. Box 1159, Cincinnati, Ohio, November, 1969, Page II, 5-16.

CHAPTER IV

WATER AND RELATED LAND RESOURCE PROBLEMS

The basic problem related to resource use is that of providing man's material needs and wants with minimal adverse effects on his environment. The specific problems discussed in this chapter result primarily from man's exploitation and mismanagement of the resources discussed in Chapter II, and general disregard of environmental values during the economic developments discussed in Chapter III.

Land Use

About 65,100 acres of land in capability classes VI and VII (suitable only for pasture, forest, or less hazardous uses) was still being used for cropland in 1967 as shown in Table II-3. Another 105,300 acres of land in capability class IV was in cropland. At the same time, over one million acres of class I and II land (best suited for cultivated crops) were used for pasture and forests. Every year builders are allowed to develop flood plains and other lands which may be the only land remaining in a particular area that is best suited for recreation, parks, or similar uses. Numerous organizations and individuals protest the encroachment on wetlands for uses other than wildlife habitat and recreation.

These examples illustrate the problem of adapting land use to capability and suitability. Particularly in urban areas, economic expediency often determines the use of specific land areas. This frequently results in undesirable environmental patterns and further inefficiencies in productive use. The problem is complicated in that the imposition of legal constraints invokes the peril of encroachment on traditional rights in the use of private property.

The most hazardous agricultural practice from the standpoint of soil conservation is cultivation of food and grain crops. Lands with minor or no conservation hazards or limits on use (capability classes I and II) are best suited for these crops. Pasture and forest are best adapted on lands not suited for more intensive or more hazardous uses. Steep mountains, wetlands, and similar areas are generally best adapted for their environmental and recreational values. The central problem becomes one of how to most nearly achieve land uses adapted to the land capabilities and limitations.

Forest Management

Substantial further increases in demand for timber products is expected to continue in the years ahead. The Nation's expanding markets for timber products are being supplied by young-growth forests in the east and old-growth forests in the west and by importation of about 10 percent of the total wood used. By the

year 2000 the projected timber supplies will fall considerably short of the Nation's projected demands for timber under the present level of management. By 2000 the demand for sawlogs will double, the veneer log demand will triple, and the demand for pulpwood will quadruple. Future imports are expected to balance with exports.[1/] This conclusion leaves us with two alternatives. We can scale back domestic consumption and exports of timber products in the years ahead. This would involve higher prices and a shift to substitute materials. Or, we can increase our efforts to produce more timber. Since full growing potentials of most forest lands are not yet being realized, the alternative, to increase the level of forest management, is the most logical.

Comparison of the projected National, regional and Basin supply and demand for forest products indicates growing deficits for the Nation, the North Atlantic Region, and the Basin (Table IV-1). The Nation's demand for timber is expected to exceed the supply by 17 percent in 1980, 50 percent in 2000, and 70 percent in 2020. In 1962, 33 percent of the Nation's land area, or 497.5 million acres was in forest, containing 11,372 million cubic feet of roundwood timber products. By 2020, the supply is expected to increase 1.8 times to 20,394 million cubic feet. In 1962, the total volume of the Nation's timber consisted of 34 percent pulpwood, and by 2020 is expected to increase to 51 percent.

In 1962, the North Atlantic Region comprised 64.2 million acres of forest land containing 754 million cubic feet. This represented 13.2 percent of the Nation's forest land and produced only 7.2 percent of the Nation's timber within an area which comprises 25 percent of the Nation's population. NAR population in 2020 is expected to be 22 percent of the Nation's, indicating NAR will maintain approximately its prorate share of population. By 2020, the NAR supply is expected to increase 2.5 times. In 1962, the NAR's demand for timber had exceeded the supply by 319 percent; by 1980, demand is expected to exceed supply by 347 percent; by 2000, this margin is expected to widen to 378 percent; and by 2020, is expected to be 410 percent.

In 1962, the Basin comprised 4.4 million acres of forest land containing 104 million cubic feet (Table IV-1). This means the Basin is producing slightly more than 0.9 percent of the Nation's timber on almost 0.9 percent of the Nation's forest land. In 1962, the Basin's demand for timber had exceeded the supply by 150 percent; by 1980, demand is expected to exceed supply by only 114 percent; by 2000, this margin is expected to widen to 144 percent; and by 2020, is expected to be 166 percent.

1/ The Demand and Price Situation for Forest Products, 1969-70.

Undercutting of roadbank and surface by floodwater on Highway 6, east of Faber and north of Schuyler, Virginia.

Scouring, deposition, and debris on flood plain along Tye River on Highway 29 at Nelson-Amherst County line.

Table IV-1. Projected National, regional and Basin supply-demand for forest products, James River Basin

Area		1962	1980	2000	2020
			Million Cubic Feet		
United States	Supply 1/	11,372	16,284	19,379	20,394
	Demand 2/	10,243	19,080	29,120	34,600
	Deficit	+1,129	-2,796	-9,741	-14,206
North Atlantic Region	Supply 3/	821	1,360	1,900	2,050
	Demand 3/	2,622	4,726	7,175	8,402
	Deficit	-1,801	-3,366	-5,275	-6,352
James River Basin	Supply 3/	104	140	209	225
	Demand 3/	156	159	301	373
	Deficit	-52	-19	-92	-148

1/ Supply projections assume that recent levels in management would continue through projection period; National Forest projected supplies would approximate current allowable cut under constraints of multiple-use management; non-National forests in the eastern U.S. projected supplies assume to rise from 90 percent of projected growth in 1970 to 100 percent of projected growth in year 2000; non-National forest supply in west was projected from actual timber harvest in 1968 to projected growth in 2000; Tennessee, Alaska, and Hawaii Regions are not included in supply.

2/ Demand projections are based on the consumption of domestic roundwood determined by population, economic activity, technology, prices of timber products relative to competing materials, imports, and exports.

3/ Preliminary projections of economic activity in the agricultural, forestry, and related economic sectors of the U.S. and its water resource regions, 1980, 2000, and 2020.

Problems

Improper Logging Practices. The construction and use of logging roads and skid trails causes the greatest impact on forest land. Logging roads and skid trails account for 695 miles of critical eroding areas with 305 miles on private lands, and 390 miles on National forests. Much of this critical area is the result of poor location and construction without proper regard for diverting runoff from the road, not providing adequate filter zone between road and stream, and not providing vegetative cover on roadbanks.

Imbalance of Softwoods and Hardwoods. One of the most significant forest management problems is the imbalance of hardwood growing stock over softwood growing stock. Too many forest stands, upon harvesting the softwoods, are left to regenerate to hardwood. This trend has left the Basin with only 19 percent of the forest land containing stands of softwood.

Forest Land Grazing. Cattle graze on 507,000 acres, or 11.5 percent of all the forest land. The largest area grazed is 291,000 acres in the Blue Ridge and Piedmont. The heaviest concentration is in the Ridges and Valleys, where 200,000 acres are grazed. The least impact is in the Coastal Plains where only 16,000 acres are grazed.

Erosion[1/]

Sheet, gully, wind, stream, and road bank erosion and flood plain scour all occur in the James River Basin. Soil loss has resulted in reduced crop production, monetary value of productive land, wildlife harvest, recreational activity, and increased cost of road maintenance and construction. Probable soil loss[1/] is estimated at 2.4 tons per acre. Present erosion damages are estimated at $5.7 million annually.[1/]

Sheet erosion and minor gullying on upland cropland is a serious problem in all provinces except the Coastal Plain. Scattered areas of critical sheet and gully erosion are located primarily in the Piedmont. The problem of streambank erosion is relatively minor and the cost of corrective measures far exceed the direct economic benefit.[2/] Erosion in road cuts, particularly in micaceous soil, is a serious problem. Some scouring of flood plains exists but does not appreciably affect the use or productivity.

Erosion rates are within tolerable limits for pasture and forest land use. Acreage used for row crops will steadily decline, but inadequate conservation treatment on the remainder will continue to be a problem.

Erosion rates on land used for urban development average 16.39 tons per acre annually (Table IV-2) and exceed 100 tons on some sites. Urban area development is taking place at the rate of 6,000 acres annually. Control of sediment and erosion in construction areas is a major problem in the Basin despite the relatively small areas involved.

1/ Erosion and Sedimentation, USDA, North Atlantic Regional Water Resources Study, December 1968.

2/ Streambank Erosion Study, Middle Atlantic Region, U.S. Army Corps of Engineers, 1969.

Table IV-2. Probable soil loss in tons per acre per year by subarea and land use, James River Basin

Land Use	Physiographic Province[1/] Ridges and Valleys	Blue Ridge and Piedmont	Coastal Plain	James River Basin Weighted Average[2/]
Cropland				
Inadequately Treated	8.4	11.29	3.83	8.91
Adequately Treated	4.2	5.64	1.92	4.56
Pasture	1.7	1.69	0.85	1.66
Forest	1.2	0.60	0.28	0.66
Urban	24.8	26.74	5.78	16.39
Other	5.6	6.18	11.2	7.35
Weighted Average	2.48	3.19	1.57	2.39

1/ For identification of physiographic provinces, see Figure 5.
2/ North Atlantic Regional Water Resource Study.

Source: North Atlantic Regional Water Resource Study.

The total annual soil loss of about 15 million tons occurs primarily on the 60.9 percent of the lands on which sheet and gully erosion is the dominant conservation hazard (Table II-3). The pattern of soil loss shown in Table IV-3 is based on the assumption that the soil losses occurred on land capability subclass "e" soils; acreage for subclass "e" soils were multiplied by the soil loss rates in Table IV-2 and reduced to percent by subarea and land use. About 74.5 percent of the annual soil loss occurs in the Piedmont-Blue Ridge subarea which comprises 54.0 percent of the Basin (Table II-1). About 30.7 percent of the annual soil loss occurs on inadequately treated cropland which comprises only 7.5 percent of the land area. Uncontrolled erosion in construction areas contributes significantly to the 30.8 percent of the annual soil loss which occurs in urban areas. Table IV-4 shows this data as estimated in tons per year and indicates that annual gross erosion equals about 10.7 million tons in these land use categories. Erosion of roadsides, streambanks, and other miscellaneous areas adds about 4.3 million tons of sediment.

The gross erosion rates for both present and accelerated land treatment levels are shown in Table IV-5. The leveling off of the rate of erosion between 1980 and 2000 reflects the increased acreage of cropland undergoing treatment. The increase in the rate of erosion after 2000 is due to urban expansion. The erosion rate is highest in the Piedmont and Blue Ridge and lowest in the Coastal Plain. Flatter gradients and greater abundance of pervious

Table IV-3. Pattern of soil loss[1] by subarea and land use, 1968, James River Basin

Land Use	Physiographic Province: Ridges and Valleys	Blue Ridge and Piedmont	Coastal Plain	Total
		Percent		
Cropland				
Inadequately Treated	4.4	25.1	1.2	30.7
Adequately Treated	1.8	5.9	.4	8.1
Pasture	2.4	4.7	.1	7.2
Forest	5.8	10.0	.7	16.5
Other	1.1	4.1	1.5	6.7
Urban	2.9	24.7	3.2	30.8
Total	18.4	74.5	7.1	100.00

1/ Based on the assumption that the soil loss occurred from land capability subclass "e" soils as presented in the 1967 Conservation Needs Inventory and gross annual soil loss rates shown in Table IV-2. Urban areas were estimated to occupy subclass "e" soils in the same proportion as farm and forest land in each subarea.

Table IV-4. Annual erosion distribution by subarea and use, 1967[1], James River Basin

Land Use	Ridges and Valleys	Blue Ridge and Piedmont	Coastal Plain	Total
		Tons per year		
Cropland				
Adequately Treated	191,268	629,334	42,902	863,504
Inadequately Treated	467,544	2,677,040	123,154	3,267,738
Pasture	258,400	501,211	10,030	769,641
Forest	619,800	1,072,320	71,988	1,764,108
Other	116,480	443,724	160,160	720,364
Urban	311,835	2,633,168	346,424	3,291,427
Total	1,965,327	7,956,797	754,658	10,676,782[2]

1/ Based on 1967 CNI use shown for land capability subclass "e" soils and gross annual erosion rates in Table IV-5. Urban areas were estimated to occupy subclass "e" soils in same proportion as farm and forest land in each subarea.

2/ Erosion on land capability subclass "s" and "w", streambanks, roadsides, and other miscellaneous areas would add about 4.3 million tons to this total.

Table IV-5. James River Basin projected gross erosion rates by subarea, annual soil loss in tons/acre/year, James River Basin

Physiographic Province	Level of Land Treatment[1/]					
	Present			Accelerated		
	1980	2000	2020	1980	2000	2020
Ridges and Valleys	2.58	2.69	3.26	2.51	2.55	3.13
Blue Ridge and Piedmont	3.40	3.66	4.71	3.31	3.47	4.51
Coastal Plain	1.88	1.80	2.35	1.82	1.73	2.26
Basin Average	2.61	2.65	3.37	2.53	2.49	3.22

1/ Under present and accelerated levels of conservation treatment.

sands and gravels cause the lower rates in the Coastal Plain. The intermediate position of the Ridges and Valleys is due to greater slope and areas of rock outcrop.

Sediment[1/]

Erosion in the James River Basin produces about 1.2 million tons of sediment annually. The sediment delivery ratio averages about 7.5 percent of the gross erosion rates discussed above. The pattern of the sediment source by land use and subarea would approximate that shown for annual soil loss in Table IV-3. Sediment is an especially acute problem in and immediately below construction areas. These relatively limited areas cause a disparate amount of the sediment damages.

Sediment damage to flood plain land and improvements, water supply reservoirs, and other impoundments is estimated at $3 million annually.[1/] Assuming continuation of the present level of land treatment, sedimentation rates will increase from 115 tons per square mile per year to 162 tons per square mile per year in 2020 (Table IV-6). Present and projected sedimentation rates by subarea are shown in Table IV-7. As in the case of erosion, the leveling off or decrease in sedimentation rate between 1980 and 2000 relfects the influence of more cropland anticipated under treatment measures. The increase in erosion after 2000 is due to urbanization.

1/ Erosion and Sedimentation, USDA, North Atlantic Regional Water Resources Study, December 1968.

Table IV-6. Rate of sediment yield in tons per square mile per year for varied size drainage areas, James River Basin

Drainage Area Sq. Miles	Year			
	1968	1980	2000	2020
1	444	484	492	626
10	275	301	305	388
100	145	159	161	205
1,000	63	68	70	88
Basin Average	115	125	127	162

Source: Erosion and Sedimentation, USDA, North Atlantic Regional Water Resources Study, December 1968.

Table IV-7. Rate of sediment yield in tons per acre/year by subarea, James River Basin

Physiographic Province			Level of Land Treatment[1/]				
			Present		Accelerated		
	1968	1980	2000	2020	1968	2000	2020
Ridges and Valleys	.186	.193	.202	.24	.188	.191	.235
Blue Ridge & Piedmont	.239	.255	.274	.35	.248	.260	.338
Coastal Plain	.118	.141	.135	.17	.136	.130	.170

Approximately 213,200 acres of upstream flood plain land are subject to sediment damages. Sediment deposits as a result of the floods and landslides during Hurricane Camille in 1969 clogged channels and damaged flood plain lands. As a partial measure of damages caused by this storm, an estimated $4 million in emergency funds were required for channel restoration to prevent immediate recurrence of floods.

Floodwater

Approximately 213,200 acres are flooded by the 100-year frequency storm along the tributary streams of the Basin. About 159,000 of these acres are flooded every five years. The present land use of the flood plain is approximately 48 percent in crops and pasture, 46 percent in forest land and 6 percent in urban and other uses.

Average annual floodwater damages in upstream watershed areas amount to $3.7 million (Graph 4).[1] Approximately 56 percent of these damages occur to urban and commercial properties, 22 percent to crops and pasture, 5 percent to improvements associated with agricultural production, and 17 percent to transportation facilities. Loss of life has also occurred during previous floods. A relationship between flood plain land use and floodwater damages are shown on Graphs 4 and 5.

Watersheds in the Ridges and Valleys have the highest damage per flood plain acre. This is primarily because of the numerous towns and cabins located along streams. Nearly 77 percent of the total damage in this region is to homes, cabins, and commercial properties. The Blue Ridge-Piedmont ranks second in damage per flood plain acre where agricultural damages account for 53 percent of the total. The Coastal Plain has the lowest damage per flood plain acre where nearly 93 percent of the area is in forest land. Detailed damages and land use by CNI watersheds are shown in Appendix A.

Impaired Drainage

On 579,300 acres excess water is the dominant problem affecting agricultural or other uses. Approximately 99,500 acres of wet soils are in cropland, 59,800 acres in pasture, 378,500 acres in forest land, and 41,500 acres in other uses. Tables II-4 through II-6 show the breakdown of these land capability subclass "w" soils by subarea.

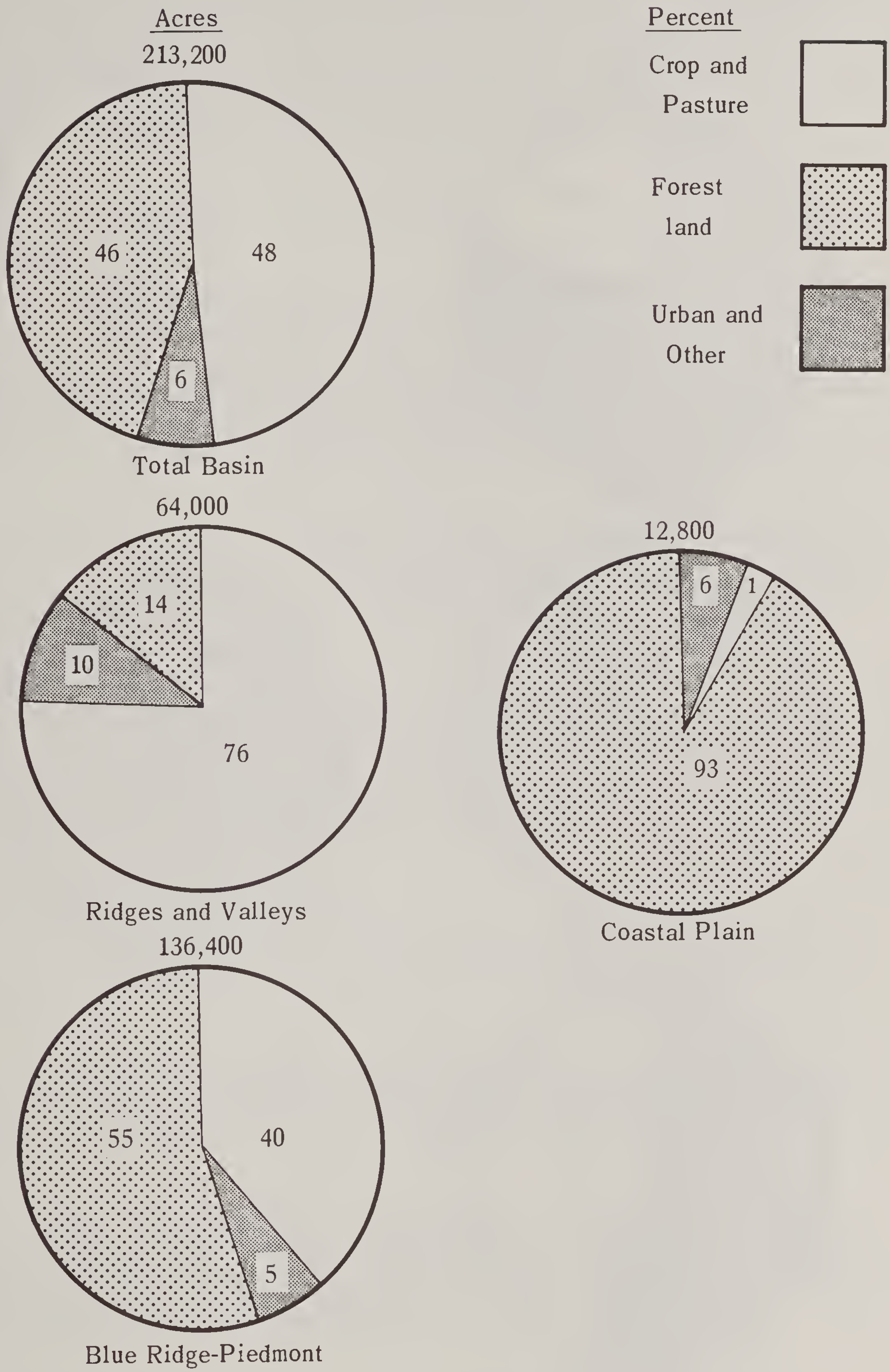
Drainage problems of the Ridges and Valleys are caused primarily by seepage from adjacent uplands. Wet pockets in the flood plain and on adjacent terraces are common throughout this area.

In the mountainous Blue Ridge subarea, drainage is not a problem. However, in the Piedmont poor drainage occurs along many of the tributary streams. Over the years, sediment deposited in the streams from eroding uplands has blocked outlets and swamped out productive agricultural lands. In other areas of the Piedmont, the presence of surface water creates some problems. Some heavier soils require internal drainage for agricultural use.

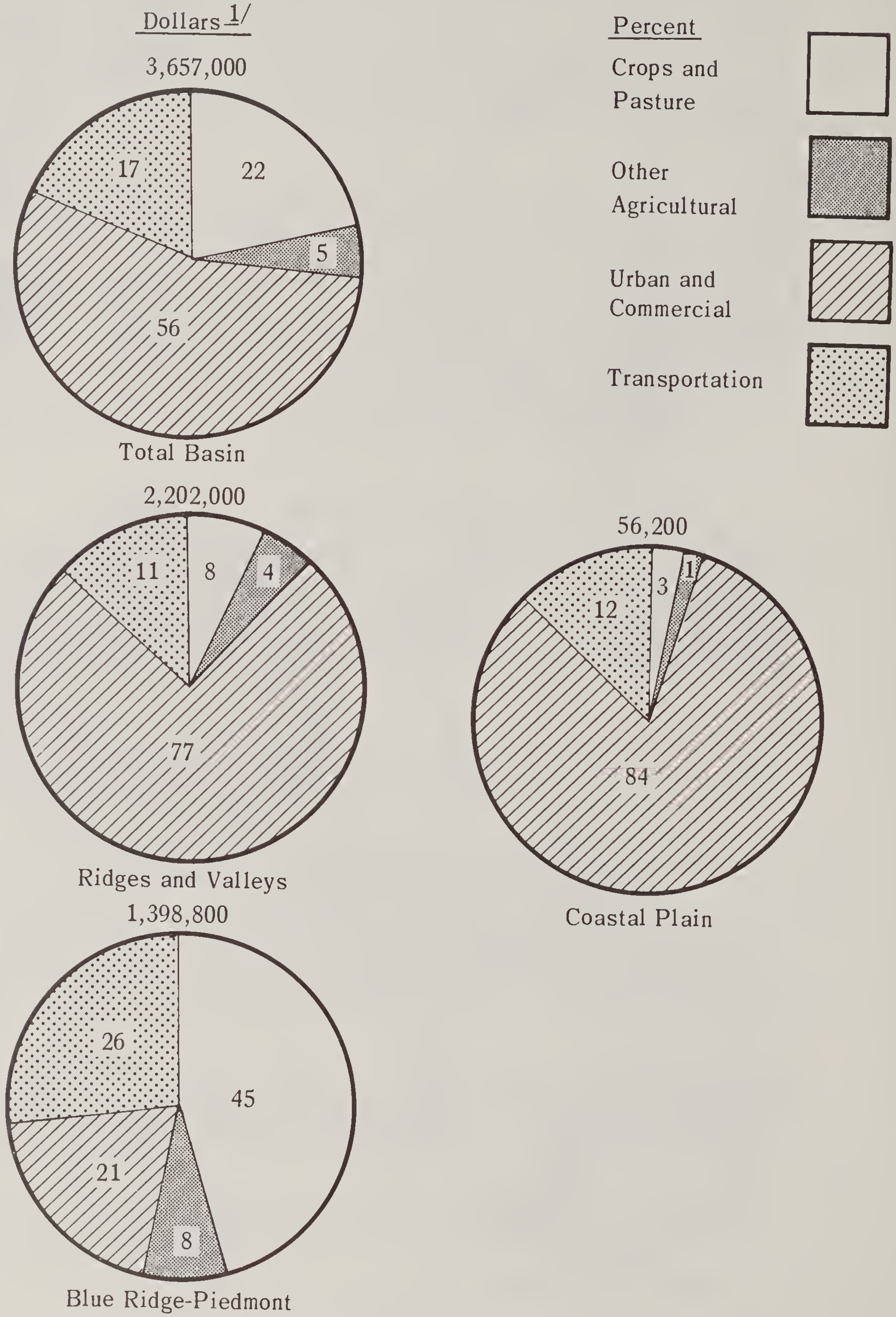
In the Coastal Plain, with a wider range of cropping systems, poor drainage is a common problem. Flat gradients cause drainage problems in adjacent areas. Both surface and internal drainage are used to eliminate these conditions.

1/ Based on frequency damage analysis described in Watershed Investigation Reports.

Graph 4. Flood plain acres in upstream watersheds, James River Basin



Graph 5. Average annual floodwater damages in upstream watersheds, James River Basin



1/ Base year of dollar value - 1967. These damages account for future increases in per capita income.

Inadequate drainage in urban areas adds to these problems. The capacity of old conduits and channels are frequently too small to carry added runoff from upstream developments. Also, municipal and county officials often do not have ordinances or information to require adequate drainage systems for new developments, or to regulate development of areas where adequate drainage and sewage disposal cannot be provided except at exorbitant costs.

Water Supply

Agricultural Crops

The amount and distribution of rainfall is generally adequate for crops grown in the Basin. The frequency and severity of drought conditions has not made irrigation economically feasible, except for high value crops or conditions allowing low-cost operations. Severe drought conditions prevailed in portions of the Basin in 1930 and 1966 but no pattern is apparent in the frequency, extent, and severity.

The practice of applying supplemental water through a sprinkler system has been used to a limited extent to irrigate corn, orchards, tobacco, and vegetables. Farm ponds have been and will continue to be the principal source of irrigation water in upstream areas. The topography does not lend itself to the surface application method of irrigation.

In 1964, 4,340 acres of agricultural lands were irrigated. Historical projections show only a moderate increase in irrigated acreage by the year 2020. This increase can be met through current irrigation programs. Water supply for irrigation of golf courses and similar uses will be provided by the user or considered with other municipal needs.

Rural Domestic and Livestock

Water for domestic use in the rural areas is supplied largely by wells. Water is also supplied to a lesser degree by springs and cisterns.

Problems arise mainly during prolonged drought when many wells and springs fail. However, rural domestic water supply problems are not expected to increase to a point where project action is needed.

Even mild drought conditions cause shortages in many rural communities and small towns. Generally, storage and distribution facilities have not been provided for increasing demands. Financing storage and distribution systems will be the primary problem of most of these small communities.

Water for livestock is supplied from springs, streams, farm ponds and wells. Seasonal shortages have largely been overcome by the development of springs and seeps and by the construction of farm ponds. Livestock water supply problems can be met through present USDA programs.

Municipal and Industrial

In upstream areas the lack of adequate storage and distribution systems has been a factor in limiting industrial and related urban development. This aggravates the problems of underemployment in rural areas of the Basin. Improvement of economic conditions is partly dependent on coordination of various programs to assist these areas in developing water supply and distribution facilities.

The Virginia Department of Conservation and Economic Development has appraised the water supply needs in the James River Basin.1/ This appraisal indicates that additional flow will probably be required in the James River to meet public industrial water supply demands in 1980 in the Covington, Clifton Forge, Alleghany County and Richmond, Chesterfield, Henrico, and Hanover County subareas. The Roanoke City area is also considering the transfer of James River Basin water to meet that area's water needs.

Supplemental flow to maintain municipal water supply withdrawals in 1980 may be required in the Covington, Lynchburg, and Maury River areas.

Forest Fires

Fire protection for State and private, Federal, and industrial forest land in the Basin is handled respectively by the Virginia Division of Forestry, the U.S. Forest Service, and various pulp, lumber, and wood-using industries. Usually cooperative agreements for fire suppression exists between these groups.

The average size of forest fires between 1957-1967 was 5.6 acres with an annual variation from 3.3 acres in 1961 to 13.5 acres in 1963. Percent of protected area burned for the same period averaged 0.084 with an annual variation ranging from 0.027 in 1961 to 0.320 in 1963. The State fire loss index goal is 0.25 percent. During the period from 1957-1967, this fire loss index was slightly exceeded only during 1963.

1/ These needs are outlined in a letter to the Norfolk District, Corps of Engineers dated January 7, 1972.

Both smoking and debris burning were each responsible for about one-fourth of all causes of forest fires. Railroads and incendiary causes of forest fires followed next in importance.

The highest acreage burned and the highest percent of total number of fires occurred during the months of April and November.

These forest fire statistics show an excellent 10-year record, which does not warrant either additional manpower, equipment, or facilities that are not presently available under going programs.

Pollution

Sources and Types

The significant problems of stream pollution in upstream watersheds are related to sediment and agricultural chemicals. USDA programs contribute only indirectly to abatement of sewage and industrial waste pollution along the major tributaries and main stem of the James River.

Problems related to sediment pollution are substantially those discussed above in the sections on land use, erosion, sediment, and floodwater problems. The discussion of erosion problems indicates that inadequately treated cropland, developing urban areas, other construction areas, and untreated roadsides are the principal sources of sediment. Although sediment yield rates are much lower on forest land, the larger aggregate area contributes substantially to sediment problems.

The widespread use of herbicides, pesticides, fertilizers, and other agricultural chemicals may contribute to water pollution problems. The extent and severity of this type of pollution is difficult to assess and is subject to further study. The Environmental Protection Agency and various State agencies are assessing the severity of this problem and it is their responsibility to monitor and control pollution.

"Environmental pollution" is a problem of growing concern throughout the Basin. Automobile "grave yards", roadside litter, and indiscriminate dumping of other solid wastes degrade the visual quality of the environment. A corollary problem involves selection of sanitary landfill sites according to suitability and capability which is complicated by conflicts among local jurisdictions as to the location and use of these sites.

Effects

Sediment aggravates practically every physical problem or damage that can be listed as related to use of land and water.

Sediment deposited in stream channels and drainage conduits increases the frequency, depth, extent, and damage of flooding. It adds to costs of water treatment and encroaches on the storage capacity of reservoirs. Sediment particles serve as vehicles for waterborne germs and viruses and, in more direct ways, degrade the quality and limit the use of water by man as well as fish and other aquatic life. Silt and sediment reaching the lower estuary of the James destroys oyster beds and upsets the delicate ecological balance of other saltwater species.

Impairment of the Natural Environment

The misuse and improper treatment of water and related land resources discussed above are contributing problems to environmental degradation and pollution. Many other complex and interrelated factors affect the quality of the environment. An added complication is the difficulty of measuring the healthful, visual, cultural, and esthetic values. This section is limited to a general discussion of the causes and resultant problems of environmental impairment.

Water Related Problems

Muddy waters and scars of roadside and streambank erosion are the dominant water related distractions from the esthetic values of the landscape. Uncontrolled erosion in urban, industrial, and highway construction areas is more severe but of more limited scope. Overgrazing and other improper land use practices have caused small and widely scattered scars from gully erosion.

The record rainfall of August 19 and 20, 1969 (Hurricane Camille) left an estimated 2,000 acres of landslide areas stripped to bedrock or infertile subsoil. These slides are mostly in Nelson County and range in size from less than one-tenth acre up to about seven acres. Revegetation is not economically feasible on most of these areas. Hurricane Agnes provided greater flood stages than Camille, but it did not cause environmental damage to the extent that Camille did. Less severe floods litter flood plains with woody debris and other trash, and smother grass and shrubs with deposits of silt and sediment. Industrial wastes and inadequately treated sewage are the principal causes of unsightly and odorous stream pollution in urban areas.

Other Problems

Urban sprawl, industrial expansion and highway developments are encroaching on the relatively unimpaired rural areas at a

rate of about 6,000 acres per year.[1] As implied in the discussion of land use problems and other sections, available guidance, tools, and technology are not being fully utilized in land use planning. Economic expediency too often determines land use. Additional residential developments are frequently wedged into areas which already lack parks, green belts, or other open spaces. Often, flood prone areas are best suited for recreation uses by virtue of their location, soil capability, and the flood hazard. Shopping centers and parking lots continue to encroach on these areas. These and similar activities result in overcrowding in some areas and lack of facilities and convenient access for enjoyment of the natural environment in other areas. Associated problems have to do with the sewage, garbage, and solid waste disposal as previously discussed.

The agricultural and rural sector has made considerable progress in adapting land use to capability in the recent years, but problems remain. Forests are still being cleared from hillsides which then may be scarred by unsightly erosion. Brushy swamps and open wetlands are cleared and drained for agricultural use as well as for urban-type development. This not only destroys existing visual and cultural values but encroaches on the habitat of unusual waterfowl and myriad other wildlife species.

These examples serve to illustrate the complexity of problems related to impairment of the natural environment. Again, the basic problem is how to resolve the conflicts between economic demands with needs to maintain and enhance the quality of the environment.

Fish and Wildlife

The basic fishery problem is the lack of adequate fish habitat to supply the demand for fishing opportunities. There are four major factors which intensify the problem.

1. Pollution, including sedimentation, industrial wastes, pesticides, fertilizer, thermal pollution, and residential sewerage; is constantly degrading, and in some cases, destructive to fish habitats.

2. Land use changes are often detrimental to stream fisheries. Such practices as channel alteration, clearing forest land, and drainage of bottomland tend to destroy or degrade the fishery habitat.

1/ Obtained by comparing average changes in built-up and urban areas in 1958 and 1967 Conservation Needs Inventory.

3. Rural to urban population shifts remove people from fishing opportunities. Many large centers of population have little or no fisheries within easy driving distance.

4. Conflicts of interest reduce fishing opportunities. Many landowners lease fishing rights on streams flowing through their farms. Others lease fishing rights to small private clubs.

Wildlife problems arise primarily from the encroachment on habitat, including wetlands, for other uses. Habitat is being reduced by urbanization, highway construction, and similar developments. Currently accepted farming practices such as clean tillage and use of herbicides destroy wildlife as well as the natural habitat. Even good land use and conservation measures, such as retirement of cropland, often upset the ecology of many areas.

Recreation

Supply-Demand Deficit

The supply-demand deficit is equal to the demand for outdoor recreation opportunity less the present capacity of existing resources and facilities.[1/] Similarly, projected needs are the difference between projected demand and supply. The measurement of outdoor recreation needs or unsatisfied demand in annual outdoor recreation days is shown in Table IV-8. In computing needs, programmed additions of land, and facilities are assumed to be in available supply by 1980.

Planned but unprogrammed supply by public agencies, increases in incidental recreation supply, and supply resulting from increases in the supply of the private sector would reduce needs accordingly.

For the Basin as a whole, there are severe shortages of nonwater dependent or enhanced recreation opportunities on class I lands. These needs are felt most in the Norfolk subarea where most of the Basin population is concentrated. There are also critical shortages of water enhanced recreation opportunity on class II and III lands with most of these needs being reflected in the Norfolk and Richmond subareas. The need for water dependent opportunities is most apparent in the Norfolk and Richmond subareas, being fairly well distributed between class I and class II lands.

The natural resources of the Basin, including recreation resources, occur without regard to people and their needs.

1/ Definitions of supply-demand and price relationship can be found in the Bureau of Outdoor Recreation Report for the James River Basin. This report can be obtained from the Bureau of Outdoor Recreation, Atlanta office.

Table IV-8. Annual outdoor recreation demand, supply and deficit by subarea and water dependency level, James River Basin

Subarea	Year	Demand WD1/	Demand WE2/	Demand Total	Supply WD1/	Supply WE2/	Supply Total	Deficit WD1/	Deficit WE2/	Deficit Total
		Annual Outdoor Recreation Capacity (1,000's)								
Appalachia	1965	458	3,147	3,605	220	2,868	3,088	238	279	517
	1980	878	4,763	5,641	436	3,042	3,478	442	1,721	2,163
	2000	1,606	7,942	9,548	436	3,042	3,478	1,170	4,900	6,070
	2020	2,466	11,861	14,327	436	3,042	3,478	2,030	8,819	10,849
Appomattox	1965	815	5,198	6,013	423	1,511	1,934	392	3,687	4,079
	1980	1,543	8,138	9,681	423	1,521	1,944	1,120	6,617	7,737
	2000	2,929	13,927	16,856	423	1,521	1,944	2,506	12,406	14,912
	2020	4,796	22,167	26,963	423	1,521	1,944	4,373	20,646	25,019
Richmond	1965	1,484	8,691	10,175	523	953	1,476	961	7,738	8,699
	1980	2,681	12,848	15,529	656	1,363	2,019	2,025	11,485	13,510
	2000	5,053	23,115	28,168	656	1,363	2,019	4,397	21,752	26,149
	2020	7,969	35,555	43,524	656	1,363	2,019	7,313	34,192	41,505
Norfolk	1965	2,129	12,374	14,503	499	8,870	9,369	1,630	3,504	5,134
	1980	3,749	18,368	22,117	499	8,879	9,378	3,250	9,489	12,739
	2000	6,450	29,498	35,948	499	8,879	9,378	5,951	20,619	26,570
	2020	9,222	41,391	50,613	499	8,879	9,378	8,723	32,512	41,235
James River Basin	1965	4,886	29,410	34,296	1,665	14,202	15,867	3,221	15,208	18,429
	1980	8,851	44,117	52,968	2,014	14,805	16,819	6,837	29,312	36,149
	2000	16,038	74,482	90,520	2,014	14,805	16,819	14,024	59,677	73,701
	2020	24,453	110,974	135,427	2,014	14,805	16,819	22,439	96,169	118,608

1/ Water dependent recreation activities.
2/ Water enhanced recreation activities.
Source: 1972 Bureau of Outdoor Recreation Report for the James River Basin.

Recreational opportunities in most instances are not available in satisfactory quality or variety close to where the majority of people live. This unfortunate circumstance of resource availability cannot be changed without redistribution of the population. It is, therefore, paramount that land use planners consider all factors of human welfare carefully, prior to the final commitment of land located in close proximity to large numbers of people. Land use considerations which affect the efficient use of the Basin's recreation resources are discussed in latter sections.

CHAPTER V

PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCES

The problems identified and described in Chapter IV are translated into current and projected needs in this chapter. This is accomplished within the framework of the natural resources described in Chapter II and the related socioeconomic situation described in Chapter III. Therefore, in this chapter we discuss topics similar to those found in Chapter IV, but our discussion concentrates on the needs of the Basin as related to the problems being experienced.

Institutional and Environmental

An essential need related to resource development in the Basin is the reversal of traditional attitudes which have resulted in the degradation of man's environment. Recent legislation and directives require that environmental considerations be one of the principal criteria in the administration of Federal programs. Similar regulatory laws and ordinances are needed at State and local levels to supplement voluntary adherence to principles which benefit property owners as well as the general public. A secondary purpose would allow legal restraints when needed to protect the general public from the results of individual actions.

As implied above, greater emphasis is needed in all resource programs to assure that land is used according to its capability and treated according to its needs for conservation and sustained production of the needs and amenities of life. All resources must be used first to provide the material necessities of society, but they should be used and managed insofar as practical to enhance esthetic, healthful and other environmental values.

Planners and developers of urban areas have a particular need for application of tools and techniques such as those developed under USDA programs. The agricultural sector needs to continue use of the land use capability system to assist farm owners and operators for such purposes as selection of the least erodible soils for cultivated crops. This soil classification system can provide vital information for selection of waste disposal sites, zoning, and other needs of land use planners in urban areas. Advisory services need to be expanded to aid local governing bodies in preparing regulations for control of erosion in construction areas, flood plain management, and related purposes. Technical information and guidance services need to be utilized to a greater extent as a basis for decisions affecting wetlands, unique scenic areas, and other esthetic and recreational resources.

Watershed Protection and Management

Problems discussed in the previous chapter indicate a need for an accelerated land treatment program or conversion of land to more desirable uses. The 1967 Conservation Needs Inventory shows that 36 percent of the cropland, 28 percent of the pasture, and 68 percent of the forest land is adequately treated. This leaves approximately 2.4 million acres needing additional land treatment measures (Table V-1).

Table V-1. Land treatment needs, James River Basin

Land Use	Total	Adequately treated	Needing Treatment
	1,000 acres		
Cropland	736.2	268.0	468.2
Pasture	655.9	182.1	473.8
Non-Federal Forest Land	3,649.3	2,229.0	1,420.3
Federal Forest Land	754.2	749.2	5.0
Total	5,795.6	3,428.3	2,367.3

Cropland

Land treatment measures needed on cropland to maintain productivity and limit erosion include the use of conservation cropping systems consisting of stripcropping, cover and green manure crops, and the growing of grasses and legumes in rotation using minimum tillage. The removal of excess runoff and seep water from uplands can be accomplished by the installation of tile drains, open ditch drains, and the use of grassed waterways and terraces in connection with contour farming. Table V-2 shows that improved treatment and management is needed on about 64 percent of the cropland.

Table V-2. Cropland treatment needs, James River Basin

Physiographic Province	Total	Adequately Treated	Needing Treatment
	1,000 acres		
Ridges and Valleys	142.2	64.0	78.2
Piedmont-Blue Ridge	439.2	140.5	298.7
Coastal Plain	154.8	63.5	91.3
Total	736.2	268.0	468.2

Pasture

The reduction of erosion and sediment yields on grasslands can be accomplished by such practices as pasture and hayland renovation and management, the use of improved varieties of seeds, brush and weed control, lime, fertilizer, and controlled grazing. The use of herbicides and fertilizers to improve pasture conditions should not overlook the effect which the use of these methods can cause on water quality. The development of springs and seeps and the construction of troughs, tanks, and farm ponds will provide greater latitude in the use of pastures to help to reduce overgrazing. These practices will improve soil cover conditions and increase carrying capacities and net income from livestock farming (Table V-3).

Table V-3. Pasture treatment needs, James River Basin

Physiographic Province	Total	Adequately Treated	Needing Treatment
		1,000 acres	
Ridges and Valleys	254.0	58.4	195.6
Piedmont-Blue Ridge	377.6	117.1	260.5
Coastal Plain	24.3	6.6	17.7
Total	655.9	182.1	473.8

Forest Land

Effective watershed protection and management of forest land are carried out jointly. The impact of applying forest management techniques results in the need to apply watershed protection measures. The intensity of application of these measures will vary with the severity of impact and the hazards of erosion forces. The soil characteristics, the length of slope, and forest cover conditions are closely related. The nature of forest cover provides for any site an opportunity to maximize, by vegetative treatment, the control of runoff from flood producing rainfalls. However, the forest cannot prevent floods. Interception, infiltration, and soil moisture storage are the principal ways in which forest cover diminishes the peak discharges from flood producing storms. Forests, by preventing erosion and sedimentation, help to maintain stream channel capacity in order that storm flow can be carried with a minimum of flooding. The maintenance of well stocked stands of both pine and hardwood are vital to practicing good watershed management, especially on the steeper slopes.

Forestry practices need to be employed to bring present forest stands up to their level of capacity to produce wood products, improve hydrologic conditions, and develop wildlife habitat to benefit designated game species. These practices include site preparation, regeneration, timber stand improvement, harvesting techniques, and planting. The application of these practices will vary among landowners to reflect the diverse attitudes for managing the total resources of the forest ecosystem.

Forty percent of the forest land in both the Coastal Plain and Piedmont-Blue Ridge areas and 18 percent in the Ridges and Valleys area needs treatment (Table V-4).

Table V-4. Forest land treatment needs[1/], James River Basin

Physiographic Province	Total	Adequately Treated	Needing Treatment
		1,000 acres	
Ridges and Valleys	1,475.1	1,216.0	259.1
Piedmont-Blue Ridge	2,397.7	1,443.8	953.9
Coastal Plain	530.7	318.4	212.3
Total	4,403.5	2,978.2	1,425.3

1/ Includes 795,400 acres of Federal forest land; George Washington N. F., 536,200 acres; Jefferson N. F., 218,000 acres; National Park Service, 41,200 acres which will receive no cultural treatment.

Forest land restoration needs include gully stabilization, sheet erosion control, streambank stabilization, road and trail stabilization, mine area stabilization, and stream channel clearing. Approximately 5,000 acres in erosion control at an estimated cost of $1,640,200 is recommended on both National forests (Table VIII-13 and VIII-14). Approximately 12,200 acres of abandoned road and travel stabilization at an estimated cost of $2,440,000 is recommended on private forest land.

Critical Erosion Areas

Only one-half of one percent of the James River Basin is considered to be critical in terms of needing land treatment measures. Although only a small portion of the Basin, this 33,000 acres represents a disparate percentage of the annual erosion and sediment damages.

Presently land is being developed at an annual rate of 6,000 acres for residential, commercial, and industrial purposes. Carefully prepared plans with provision for temporary vegetative cover and structural measures during construction will reduce the magnitude of the erosion and sediment problems associated with such development. This not only will result in a savings to the developer and the community, but will create a more desirable environment in the immediate area and further downstream.

Another 15,000 acres of critical areas involves secondary, primary, and interstate highway system. Proper sloping and vegetating roadbanks during construction will reduce this problem and also improve the scenic qualities of highways. The installation of temporary land treatment and structural measures during construction will further reduce quantities of sediment being deposited in our streams, harbors, ponds, and lakes. Developers often create sediment problems in streams and ponds below construction projects, resulting in losses to the private individual.

Approximately 11,000 acres of agricultural land are considered critical sediment producing areas. These areas are primarily in cropland and overgrazed pasture on soils in land capability classes VI-e and VII-e. Better treatment or less intensive use is needed to reduce erosion and sediment production.

About 1,000 acres of active and abandoned mining operations need grading, shaping, and establishment of permanent vegetation.

Flood Prevention

The extent and amount of floodwater damages in upstream watersheds are summarized in Table V-5 by subareas. About 64 percent of the flood prone areas are in the Blue Ridge-Piedmont subarea, 30 percent in the Ridges and Valleys, and 6 percent in the Coastal Plain. The Ridges and Valleys suffer 60.3 percent of the economic losses because of the concentration of developments on the narrow valleys of the subarea. Crop and pasture damages constitute the major portion of economic losses in the Blue Ridge-Piedmont subarea, which comprise 38.2 percent of the Basin total. Only 1.5 percent of these losses accrue in the Coastal Plain.

Needs for upstream flood prevention measures are greatest in the Ridges and Valleys. Roads, homes, and other developments will continue to be concentrated in flood plains which comprise most of the relatively level land in the subarea. More options are available for location of such developments in other subareas.

Improved land treatment as discussed above is the basic need and first consideration in alleviating flood problems. The next consideration is to determine to what extent flood plain management

Table V-5. Summary of extent and amount of floodwater damages in upstream watersheds, James River Basin

Subarea	Area in flood plains (Acres)	Average annual damages (dollars)
Ridges and Valleys	64,000	2,202,000
Blue Ridge-Piedmont	136,400	1,398,800
Coastal Plain	12,800	56,200
Total	213,200	3,657,000

Source: Watershed investigation reports as defined in Chapter I.

and other non-structural measures will meet flood prevention objectives. An important element of flood plain management is local zoning to prevent or limit development in the flood plains. In subwatersheds where such measures will not provide practical solutions, the physical potential and economic feasibility of structures for temporary storage of floodwaters are assessed. Channel alterations, floodways, dikes, and levees are usually the last alternatives considered.

In some subwatersheds the public interest may best be served by preserving the existing environmental resources. Other watersheds may not offer the physical features to allow use of structural measures. The results of watershed investigations and specific needs suggested for flood prevention are presented in later chapters of this report.

Drainage Improvement

The 1967 Conservation Needs Inventory indicates that 159,200 acres of agricultural land need improved drainage. To date only 23,500 acres have adequate drainage measures applied, thus leaving a need for drainage improvement measures on 135,700 acres (Table V-6). The need for group drainage projects are not applicable in most case, as the areas involved are small and can be handled through present programs.

Generally, random tile systems and open ditch drains are adequate to solve drainage problems. Occasionally, there is need for some surface land leveling in the southern Piedmont and Coastal Plain.

Irrigation

During a fifteen year period from 1949 to 1964, the acreage irrigated increased from practically zero to more than 4,300 acres in some years depending upon the severity and extent of drought.

Table V-6. Agriculture drainage needs, James River Basin

Province	Cropland			Pasture		
	Total	Adequately Drained	Needs Additional Drainage	Total	Adequately Drained	Needs Additional Drainage
	1,000 acres					
Ridges and Valleys	15.4	2.2	13.2	23.1	3.4	19.7
Blue Ridge-Piedmont	34.5	5.1	29.4	27.9	4.1	23.8
Coastal Plain	49.5	7.4	42.1	8.8	1.3	7.5
Total	99.4	14.7	84.7	59.8	8.8	51.0

Based on historical projections of irrigated lands in farms, the North Atlantic Regional Water Resource Study estimates irrigation acreages to be as follows:

For the year 1964 - 4,340 acres
For the year 1980 - 5,900 acres
For the year 2000 - 6,300 acres
For the year 2020 - 6,000 acres

This moderate increase in irrigated acreage can be met through present programs.

Food and fiber needs can be met within the Basin until the year 1990 without additional irrigated acreage. At the time when the demand for food and fiber exceeds supply, increased production measures must be used. The following irrigation acreages will meet food and fiber demands:

Year	Acres
1980	4,340
2000	54,700
2020	167,400

Based on current trends, availability of water and projected population experienced field technicians of the Soil Conservation Service estimated irrigated acreage to be as follows:

For the year 1980 - 22,000 acres
For the year 2000 - 56,900 acres
For the year 2020 - 98,000 acres

The comprehensive plan in the James River Basin based upon a goal of national efficiency is likely to utilize the lower estimates of

irrigated acres, while a plan concentrating upon regional development will concern the maximum level of irrigation development.

Gross seasonal irrigation water requirements are estimated to be one acre-foot per year for each acre irrigated.

Annual irrigation requirements have been estimated to exhibit the following ranges:

April	-	0 to 4 percent
May	-	7 to 16 percent
June	-	25 to 34 percent
July	-	25 to 31 percent
August	-	21 to 23 percent
September	-	6 to 7 percent

It is estimated that approximately 40 percent of the water for the above irrigation acreages will be withdrawn from streams in 1980. In 2020 the withdrawal from streams will approximate 20 percent of the total need.

The importance of irrigation water as compared to other water needs is highly variable between specific locations. This variation is caused by water availability and competition between other uses. Urban and industrial development are expected to increase needs for additional water for nonagricultural irrigation such as golf courses, public parks, and lawns.

At the present time, there are approximately 50 golf courses with a total acreage of 6,380. Of this only 1,235 acres are irrigated, due primarily to a lack of adequate sources of water. The pressure of population expansion is expected to increase the demand for this type of facility, particularly around the larger metropolitan areas.

Domestic and Livestock Water Supply

Domestic Water Use

The most important use of water is for human consumption and other domestic uses. Table V-7 shows the levels of domestic water consumption expected in 1980, 2000, and 2020. The urban and rural non-farm consumptive use coefficients were developed from data furnished by the Environmental Protection Agency. The rural farm coefficients were those used in the North Atlantic Region Study. Data from the 1960 Census of Housing were used to adjust the 1980 rural coefficients to reflect households without running water. It was assumed that by 2000 all households would have running water.

Table V-7. Annual domestic water use, by year, James River Basin

Year	Gallons Used Per Day Per Capita			Population			Annual Domestic Water Use			
	Urban 1/	Rural 1/ Non-Farm	Rural 2/ Farm	Urban	Rural Non-Farm	Rural Farm	Urban	Rural Non-Farm	Rural Farm	Total
	Gallons			Number			Million Gallons			
1980	115	100 3/	74 3/	657,500	434,100	42,000	27,600	14,100	900	42,600
2000	138	119	95	863,300	561,400	28,400	43,500	24,400	1,000	63,900
2020	167	123	95	1,110,600	704,000	18,900	67,700	31,600	700	100,000

1/ Developed from data furnished by Environmental Protection Agency.

2/ Coefficients used in the North Atlantic Region Study.

3/ A consumptive use coefficient of 10 gallons per person per day was used for those households without running water.

A declining annual use of domestic water by rural farm families and increasing annual use by rural non-farm and urban families are clearly established. Domestic use of water in the Basin will increase from 42,600 million gallons annually in 1980 to 100,000 million gallons in 2020.

The increase use of water in rural areas will be due almost entirely to domestic requirements; including an increase in rural population, an increase in the proportion of households with running water, and an increase in per capita water use.

Annual rural domestic water requirements have been estimated as follows:

For the year 1980	-	15.0 million gallons
For the year 2000	-	25.4 million gallons
For the year 2020	-	32.3 million gallons

For the same periods, the North Atlantic Regional Water Resources Study shows the following annual rural domestic water requirements:

For the year 1980	-	9.9 million gallons
For the year 2000	-	17.2 million gallons
For the year 2020	-	20.6 million gallons

Most of the variation in these projections is a result of differences in estimates of the proportion of the population living in rural areas. These estimates can be considered as a planning range. If large areas of urban development are annexed into new or existing cities, the lower of the estimates will be applicable. However, if little annexation occurs, the water requirements will continue to be classified as rural domestic water requirements. Realized water requirements for the earlier projection years are likely to fall within the range, especially since the range is wide.

Much of the use of water in upstream areas is near the source of the supply. Much of the supply, also, is ground water that normally replenishes itself seasonally. Use of water in upstream areas is important in that it influences the quality and quantity of water downstream.

Of greater concern in the future will be pollution of rural streams and ground water by inadequate septic systems and by agricultural chemicals.

Livestock Water Use

Another important use of water is for livestock consumption. Many factors influence the consumption of water by livestock.

Water intake by animals generally parallels the dry matter in feeds when animals are on dry feed. Also, water intake is affected by the water content of the feed itself. The level of production will also affect the intake of water. The values presented in Table V-8 will be generally applicable.

The numbers of cattle and calves, milk cows, hogs and pigs, sheep and lambs, chickens and turkeys were obtained by county from the Census of Agriculture for 1949 through 1969. These historical figures were then projected using linear regression. Subjective adjustments were made when negative projections were obtained and when the trend in numbers disagreed with projected production shares discussed earlier.

Water use rates per head per day were obtained from several sources[1/] including the NAR Study. These rates were assumed to remain constant for all projection years. It was also assumed that all water use was consumptive use; i.e., reuse of water not consumed was not considered.

Cattle and calves are projected to use 996 million gallons of water annually by 1980 and 1,562 million gallons by 2020. They will comprise 68 and 78 percent, respectively, of total livestock use.

If milk cows are included in the cattle and calves category, they will comprise 85 and 91 percent of total livestock use in 1980 and 2020. However, total annual livestock water uses represent only about 3.3 percent of total domestic and livestock uses for 1980, 2.4 percent for 2000, and 2.0 percent for 2020. It is assumed that water needed for use by livestock is readily available and no policy alternatives will be formulated specifically to supply water for livestock use.

Total Annual Water Requirements[2/]

Total annual water requirements for domestic and livestock uses are summarized in Table V-9.

Municipal and Industrial Water Supply

Municipal and industrial water supply is generally obtained from surface sources because of the large quantities needed. Population projections for the major independent cities, as determined by the Office of Business Economics (OBE), the National Planning Association (NPA), and the Virginia Division of State Planning and Community Affairs, are shown in Table V-10.

1/ See footnote 1, Table V-8.

2/ See Appendix D, for details on water requirement projections.

Table V-8. Annual livestock water use, by year, James River Basin

Type	Livestock on Farms				Water[1/] Use Per Day Per Unit	Annual Water Requirements		
		Projections				Projections		
	1969	1980	2000	2020		1980	2000	2020
	Number				Gallons	Million Gallons		
Cattle & Calves	230,595	272,900	349,500	428,000				1,562.2
Hogs & Pigs	118,325	90,000	76,000	70,000	5.00	164.2	138.7	127.8
Sheep & Lambs	48,454	55,000	57,000	57,000	2.00	40.2	41.6	41.6
Chickens	758,054	1,000,000	1,000,000	1,000,000	0.05	18.2	18.2	18.2
Turkeys	1,133	2,000	3,000	3,500	0.06	0.1	0.1	0.1
Milk Cows	28,814	19,500	20,000	20,000	35.00	249.1	255.5	255.5
Total						1,467.9	1,729.8	2,005.4

1/ Water use rates were determined using estimates made by the Agricultural Engineering Department, VPI, and other sources, including Penn State Extension Service and ERS data. In the case of milk cows, the per day use includes water used to operate drinking and washing systems.

Table V-10. Projections of population for major independent cities by years, James River Basin

Town or City	1980			2000			2020		
	OBE	NPA	OBE	OBE	NPA	VA	OBE	NPA	VA
Clifton Forge	6,400	6,190	6,700	7,900	6,330	7,403	9,880	7,972	8,180
Covington	13,500	11,242	10,000	16,800	11,495	11,050	20,700	13,900	12,200
Buena Vista	7,800	6,890	8,300	9,600	6,890	10,128	11,900	6,890	12,350
Lynchburg	67,400	69,000	65,400	83,600	83,600	69,000	72,260	69,000	78,840
Lexington	11,611	9,214	11,100	14,742	9,214	14,091	20,860	9,214	17,880
Charlottesville	34,000	37,774	51,700	37,500	44,440	69,632	42,000	44,440	93,780
Colonial Heights	16,000	27,108	20,200	22,000	40,681	33,100	26,500	43,179	54,230
Richmond	230,000	259,260	230,300	235,000	287,699	254,458	240,000	299,130	281,150
Petersburg	38,800	36,700	40,600	43,000	36,700	46,678	56,000	36,700	53,660
Williamsburg	7,400	7,228	9,800	8,000	7,228	15,476	9,000	7,228	18,900
Hopewell	26,000	23,749	29,200	32,000	49,810	47,848	36,000	103,744	78,400
Newport News	140,000	141,000	168,800	165,000	184,800	241,173	180,000	260,000	344,570
Suffolk	13,000	12,386	13,400	15,000	9,911	14,200	17,000	7,821	15,000
Total	611,911	647,741	665,500	690,142	764,198	837,497	772,960	909,218	1,070,200

Source: Office of Business Economics - U. S. Department of Commerce, National Planning Association and Division of Planning and Community Affairs, Virginia.

Table V-9. Total annual water requirements, by year, James River Basin

Use	Projections 1980	2000	2020
	Million Gallons		
Domestic Use	42,600.0	68,900.0	100,000.0
Livestock Use	1,467.9	1,729.8	2,005.4
Total Annual Requirements	44.067.9	70,629.8	102,005.4

Average per capita water use rates of 120 gallons per day in 1980, 140 gallons for 2000 and 170 gallons for 2020 are assumed. The annual municipal water requirements are shown below for these rates and projected populations (Tables V-11 and V-12). These figures again present a range of water requirements which can be used for planning purposes. The figures in the upper end of the range are similar to the urban domestic water requirements projected by ERS and shown in Table V-7. Differences may be attributed to the fact that not all urban residents receive their water from a municipal system.

Table V-11. Annual municipal water requirements, 1980, 2000, and 2020, James River Basin

1980			2000			2020		
OBE	NPA	VA	OBE	NPA	VA	OBE	NPA	VA
Billion Gallons								
26.8	28.4	29.1	35.3	39.1	42.8	48.0	56.4	66.0

Water Needs for Forest Industry

Water used by forest-based industry is largely confined to the production of paper and its allied products, although limited quantities of water are also used in the production of lumber and wood products.

Water requirements for the manufacture of products from forest resources vary not only by the product but by the processes used. Lumber mills that produce five million board feet or more per year average about 1,000 gallons of water per thousand board feet of lumber produced. The average small mill, producing about 500,000

Table V-12. Annual industrial water use requirements by year, James River Basin

Year	Employment	Intake	Discharges	Consumption
	Million Gallons			
1964	122,111	204,794	193,475	11,319
1980	151,805	433,990	400,792	33,198
2000	180,117	1,149,931	1,056,308	93,623
2020	209,234	2,743,999	2,520,746	223,253

Source: The Cornell method is discussed in the North Atlantic Regional Water Resources Study, Appendix R - Water Supply and Appendix T - Annexes.

board feet, uses 10 to 20 gallons per thousand board feet of lumber produced.[1/] A typical veneer plant may use 5,000 to 10,000 cubic feet of water per vat per week if water is used to heat logs.

In comparison, the pulp and paper industry is dependent on an adequate supply of high quality water for continuous operation. Large quantities of water are required for separating cellulose from the nonfibrous constituents of the wood and comparable volumes are needed to produce paper and paperboard from wood pulp. In addition to these process uses, the industry requires water for steam generation and cooling purposes. Water needs vary with the pulping process used and whether paper manufacture is integrated in the process. The amounts of water used also vary widely from mill to mill. Amounts vary from a minimum of 144,500 gallons for the sulfate and soda processes.

Supply-Demand for Forest Products

Data in the previous chapter indicates a surplus of forest products to meet in-Basin needs, but total demands of the Basin must be predicated upon the factors which determine timber supply and demand not only within the Basin, but throughout the Nation. When a product is in short supply, a rise in price is eminent. In 1968 and 1969, a major jump in prices of lumber and plywood occurred at a time of record new highs in housing goals for the Nation.

1/ Forest Farmer, November 1956.

In 1971, consumption of industrial wood reached an alltime peak of 13 billion cubic feet, including more than 60 billion board feet of domestic, saw log-sized material.[1/]

Census Bureau projections indicate a gain of some 75 million more people by the end of this century - a rise of around 40 percent. Most analysts expect gross national product to continue at historical rates for some time to come.

Considering these and other factors influencing materials use, demands for forest products are estimated to increase at least 80 percent by 2000; i.e., about 2 percent annually, if adequate supplies of timber are available and prices are maintained at recent levels. The highest rates of increase in such potential demands are likely to be for pulp and paper, plywood, and particleboard.

How much of this potential increase in timber usage is actually achieved will depend on what the Nation does to grow more timber, extend wood supplies by better utilization, and maintain prices of forest products at competitive levels.

Nationwide comparisons of timber growth and removals show that our most serious supply problems relate to softwood sawtimber needed for lumber and plywood. Even though cubic-foot growth of hardwoods is now some 80 percent greater than removals, supplies of the higher quality sizes of preferred species, such as maple, birch, and gum continue to decline.

The outlook for pulp and paper production is appreciably better than for lumber and plywood, partially because this industry can utilize a wide variety of species and qualities of timber. Further expansion could be supported by greater use of hardwoods, cull material, and residues, as well as by greater recycling of waste paper and continued increases in pulping efficiency. Presently, the Nation is using about 8 billion feet of softwood sawtimber annually for pulp and paper production. Diversion of some of this material to lumber or plywood production would seem desirable. However, increased competition from an expanding pulp industry for available supplies of sawtimber could result.

Water Quality

Measures needed to reduce erosion and sedimentation are discussed in the first two sections of this chapter. In implementation of upstream watershed projects, land treatment will be accelerated on the major sediment source areas.

1/ "Timber Supply and Demand", Edward P. Cliff, Journal of Forestry, September, 1972.

It is not anticipated that upstream projects will include other measures to aid in pollution abatement on the main stem and major tributaries. However, overall needs are still being studied in cooperation with other agencies and the most practical and feasible measures for meeting these needs will be jointly determined.

Further study is also needed on possible damage to fisheries resulting from installation of upstream structural measures. These studies include measures to mitigate damages that will result from inundation of streams in floodwater retarding structures and from channel authorization for flood protection or drainage. Some of the measures being considered include plans to preserve natural conditions to the greatest practical extent; construction specifications for artifical riffles, pools, spawning beds and hide areas to replace or improve existing natural values; and cold water release devices in floodwater retarding structures to maintain more favorable temperatures prior to preparation of plans of specific projects. Thorough study of each situation is needed to determine the specific measures required.

Crop and Livestock Production

If the James River Basin is to maintain its historical share of the State and National production of food and fiber, additional productive capacity will be needed after 1990. Table III-24 indicates that by 2000, 73,000 additional productive acres will be needed to produce the Basin's share of crops. This figure increases to 223,000 acres by 2020. These figures do not include the pasture acres necessary to produce the increased numbers of livestock projected for 2000 and 2020. The additional number of pasture acres is difficult to determine. It depends upon the techniques used to produce the livestock, especially the cattle and calves. If feed lots are used, land demands are not great. However, if extensive methods are used, pressures will be great for additional acres of pasture.

One way the additional cropland acres can be obtained is to convert land currently in pasture to cropland.1/ Table III-24 also shows the results of this process. If this conversion occurs, the acres of pasture remaining for livestock production in 2000 and 2020 are 337,000 and 111,000 respectively. Table III-23 indicates that livestock production in the Basin is expected to increase substantially, thereby increasing the acres of pasture needed. Therefore, we can probably assume that very few acres of pasture will be available for conversion to cropland and that, in fact, additional acres of pasture may be necessary to meet livestock production goals

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1/ Such conversions should be made only after determination that the land capability classification is suitable for cultivation.

as shown in Table III-23. Historically, acreages of cropland have been decreasing, suggesting that crop and livestock production will either (1) shift to other productive areas in Virginia or (2) Virginia's share of National production will be less than projected by OBERS. Increased soil productivity and greater flood plain protection resulting from upstream watershed development described later will help to maintain the Basin's share of production of crop and livestock products.

But increased demand for crop and livestock products can be met in several other ways, including improved management, irrigation, flood protection, drainage, or a combination of any or all of these. These measures, either singly or in combination, can add to the Basin's productive capacity or reduce production costs. A comparison of the effectiveness these measures have is useful in a comprehensive survey and can be used in the plan formulation process.

Fish and Wildlife

Sport fishing pressure will more than double by the year 2020 (Table V-13). About 160,000 acres of new freshwater ponds, lakes, and reservoirs will be needed to meet this demand. The areas of streams and saltwater available to the public will not increase significantly. In preparation of final plans for development, full consideration will be given to preservation of existing trout streams and opportunities for creating cold water lakes to fill the needs for this type of fishery. For optimal distribution the new waters should be located primarily in the Coastal Plain and Piedmont. Approximately 90 percent of the population will continue to be concentrated in this area.

Table V-13. Projected fisherman visits and new fishing water needs1/, James River Basin

Year	Annual Fisherman Visits: Fresh-Water	Annual Fisherman Visits: Salt Water	Annual Fisherman Visits: Total	Needs for new Fishing waters
	millions			acres
1970	3.2	1.8	5.0	20,000
1980	3.6	2.1	5.7	40,000
2000	4.7	2.9	7.6	90,000
2020	6.5	4.0	10.5	160,000

1/ Source: Bureau of Sport Fisheries and Wildlife, Dept. of Interior and Virginia Commission of Game and Inland Fisheries.

Public access and more convenient access to fishing waters is an important incidental need particularly in urban areas. Access to waterside areas with space for parking and bank fishing is needed to increase use of underfished waters and provide additional fishing opportunities. Only modest increases in fish harvest capability are anticipated as a result of pollution abatement, new management techniques and related developments.

The primary need related to wildlife is a continuation of current programs and projects. Trends and projections indicate only a slight increase in hunting in the Basin. Acquisition of privileges on private lands to supplement hunting on public lands will help meet the demands. A special need is added emphasis in all programs to preserve approximately 69,000 acres of wooded swamps, open wetlands, and similar areas not only for protection of wildlife, but also to maintain other recreational and environmental values.

Recreation

The supply-demand problem presented in Chapter IV resulted in a deficit of both water dependent and water enhanced recreation activities. This deficit was shown in Table IV-8 and is shown in Tables V-14, V-15, and V-16. This deficit is the need for outdoor recreation facilities which must be met in each of the projection years if the demands of the projected Basin population is met. These additional facilities will require additional acres of land and water which USDA programs can help to supply.

Relationship Between Needs and Planning

In order to show the relationship between needs, resources, and planning objectives for recreational purposes, a selection of devices or land management tools are presented for different objectives and on the basis of overall effectiveness. Highest priority is given to the recreation resources nearest population concentrations and to resources which are relatively unique regardless of location. As presented in Table V-17, a time distance continuum based on driving time from the center of the region's population concentrations shows the relative importance or priority of resource allocation. As can be expected, the closer a common recreation resource is to larger numbers of people the more pressing becomes the need for enlisting an approach which could preserve, protect, or develop its inherent value.

Table V-17 shows that clean water is a supportive element necessary to provide a quality recreational environment. For example, low water quality is considered to be a deterrent to a quality recreation environment. The quality of water can effectively

Table V-14. Projected annual outdoor recreation needs, by subarea and water dependency level, James River Basin

Subarea	Year	Annual Outdoor Recreation Capacity (1,000's)		
		Water Dependent	Water Enhanced	Total
Appalachia	1965	238	279	517
	1980	442	1,721	2,163
	2000	1,170	4,900	6,070
	2020	2,030	8,819	10,849
Appomattox	1965	392	3,687	4,079
	1980	1,120	6,617	7,737
	2000	2,506	12,406	14,912
	2020	4,373	20,646	25,019
Richmond	1965	961	7,738	8,699
	1980	2,025	11,485	13,510
	2000	4,397	21,752	26,149
	2020	7,313	34,192	41,505
Norfolk	1965	1,630	3,504	5,134
	1980	3,250	9,489	12,739
	2000	5,951	20,619	26,570
	2020	8,723	32,512	41,235
James River Basin	1965	3,221	15,208	18,429
	1980	6,837	29,312	36,149
	2000	14,024	59,677	73,701
	2020	22,439	96,169	118,608

Source: BOR Outdoor Recreation Report for the James River Basin, 1972.

reduce or eliminate a resource capacity to provide a quality recreation experience and general aesthetic satisfaction. Clean water is an inseparable part of the whole recreational environment and should exist in a form useable to man. It is assumed here that clean water should be available within two hours of population concentrations. In general, these waters should be pleasing to all the human senses and should contribute to the support of desirable life forms.

In order to satisfy the resource allocation needs of the Basin, including outdoor recreation, a variety of controls or devices in combination or singly will have to be employed. Distinctions between the two objectives shown in Table V-17 are apparent in the suggested environmental controls to be utilized and in the degree of public ownership. The environmental quality objective relies on public fee simple purchases as the more effective tool for controlling the recreation environment. Controls such as easements or purchase and leaseback arrangements are of considerable value in complementing fee simple purchases by providing buffer zones or various dimensions and restrictions.

Table V-15. Projected outdoor recreation demand in annual recreation days (1,000's) by year and use type, James River Basin

Subarea and Year	Use Few Available Hours	Use Outings	In Basin Use Overnight Trips	In Basin Use Vacations	Out-of-State Visits
Appalachia					
1965	827,400	487,000	268,995	2,187,380	2,608,200
1980	1,082,400	640,200	386,620	3,350,800	4,163,800
2000	1,845,000	1,080,000	678,594	5,620,750	6,832,800
2020	2,552,000	1,496,000	945,994	8,056,328	10,850,000
Appomattox					
1965	3,168,500	1,865,100	354.155	1,645,735	4,202,100
1980	4,992,200	2,952,700	514,800	2,508,400	6,692,600
2000	9,151,200	5,356,800	918,612	4,168,750	10,998,000
2020	15,323,600	8,982,800	1,310,897	5,903,772	17,475,000
Richmond					
1965	9,415,100	5,542,200	573,385	1,244,695	3,477,600
1980	14,615,700	8,644,600	832,480	1,897,440	5,559,000
2000	25,967,400	15,200,400	1,465,399	3,182,925	9,079,200
2020	40,036,200	23,469,500	2,043,909	4,569,460	14,450,000
Norfolk					
1965	14,336,200	8,439,000	574,465	1,613,490	4,202,100
1980	21,320,000	12,610,000	827,700	2,489,760	6,692,600
2000	33,855,800	19,818,000	1,428,375	4,300,575	10,998,000
2020	45,474,300	26,657,400	1,938,020	6,425,720	17,475,000
James River Basin					
1965	27,747,200	16,313,300	1,771,000	6,691,300	14,490,000
1980	42,010,300	24,847,500	2,561,600	10,246,400	23,108,000
2000	70,819,400	41,455,200	4,490,980	17,273,000	37,908,000
2020	103,386,100	60,605,700	6,238,820	24,955,280	60,250,000

Source: Preliminary BOR Report, 1969.

Table V-16. Projected outdoor recreation demand in annual recreation days (1,000's) by year, use type, area class, and levels of water dependency, James River Basin, Virginia

Use-Type	Year	Area Class I			Area Class II			Area Class III			Area Class IV		
		Total 1/	Water Dependent	Water Enhanced	Total	Water Dependent	Water Enhanced	Total	Water Dependent	Water Enhanced	Total	Water Dependent	Water Enhanced
Vacation	1965	8,472	593	3,472	6,355	761	3,686	4,237	127	3,856	2,119	0	2,035
	1980	13,340	1,201	5,470	10,007	1,501	5,804	6,671	334	6,071	3,336	0	3,202
	2000	22,072	2,207	9,049	16,554	2,648	9,601	11,036	662	10,043	5,518	0	5,297
	2020	34,082	3,408	13,973	25,562	4,345	14,826	17,041	1,023	15,508	8,521	0	8,180
Overnight Trips	1965	709	65	284	531	117	271	355	31	302	176	0	170
	1980	1,024	133	409	769	185	392	412	55	415	257	0	249
	2000	1,797	249	718	1,348	337	687	899	107	764	450	0	436
	2020	2,495	375	998	1,871	506	954	1,248	162	1,063	624	0	605
Outings	1965	6,534	1,039	2,482	4,901	931	2,459	3,266	195	2,920	1,634	0	1,600
	1980	11,182	1,677	4,249	7,455	1,491	3,877	3,728	261	3,333	2,485	0	2,436
	2000	18,655	2,985	7,089	12,436	2,738	6,466	6,219	497	5,557	4,146	0	4,063
	2020	27,273	4,364	10,364	18,182	4,181	9,453	9,091	818	8,115	6,061	0	5,940
Few Available Hours	1965	13,874	416	3,053	6,937	485	2,706	4,161	125	3,828	2,776	0	2,416
	1980	21,005	840	4,621	10,503	933	4,097	6,341	191	5,834	4,201	0	3,655
	2000	35,411	1,416	7,790	17,705	1,770	6,905	10,623	425	9,773	7,083	0	6,162
	2020	51,693	2,067	11,373	25,847	2,585	10,081	15,508	620	14,267	10,338	0	8,994

1/ Sum of water-enhanced and water-dependent use does not equal total use because of nonwater related use.

Source: 1969 BOR Report for James River Basin.

Table V-17. Relationship of needs to planning objectives, James River Basin

Resource Allocation Needs	Environmental Quality Planning Objective			National Efficiency Planning Objective		
	To 1 Hr.%	1-2 Hrs.%	2 + Hr.%	To 1 Hr.%	1-2 Hrs.%	2 + Hrs.%
Preservation of unique and outstanding natural biotic communities including, swamps, uplands, etc.	FS-100	FS-100	FS-100	FS-100	FS-100	FS-100
Preservation of outstanding examples of our historic heritage including battlefields, transportation routes, historic sites, etc.	FS-100	FS-100	FS-100	FS-100	FS-100	FS-100
Preservation of identified scenic rivers and streams	FS-50 ZO-50	FS-25 EA-75	FS-5 EA-95	FS-25 ZO-75	FS-25 EA-75	FS-5 EA-95
Preservation of unique landscape features such as waterfalls, gorges, promontories, etc.	FS-100	FS-75 EA-25	FS-75 EA-25	FS-100	FS-25 EA-25	FS-75 EA-25
Protection of landscape diversity and quality including forest wetlands, shorelines, mountains, pastoral, etc.	FS PL EA(20) ZO TI	FS PL EA(40) TI	FS EA(80) TI	EA ZO(10) TI	EA TI(20)	EA TI(80)
Development of quality landscapes such as reservoir projects, restoration of flood plains for urban amenities, etc.	FS-80	FS PL(80)		FS-50	PL-50	
Development of clean water	ZO(NA) TI	ZO(NA) TI	ZO(NA) TI	ZO(NA) TI	ZO(NA) TI	ZO(NA) TI

FS - Fee simple purchase - provides full control of the land.

ZO - Zoning - local regulations restricting use of land which would endanger general welfare, health or safety. Does not amount to the taking of private lands for public purposes, i.e., the development of a park.

EA - Conservation or scenic easement - provides for the granting of certain public rights to private lands; would restrict alterations of current land uses or development.

PL - Purchase and leaseback - provides for public purchase of private lands which are in turn leased back to owners with land-use restrictions.

TI - Tax incentive - provides preferential assessment or land is taxed according to its use rather than its "fair market value." This could also be in the form of a subsidy.

() - Applies to all controls.

NA - Not applicable.

The development of quality landscapes within one hour's driving time of the region's major population concentrations is judged to be of major importance. Such developments would include the construction of multiple-purpose reservoir projects and regional park developments and the restoration of flood plain lands of urban areas for recreation and related purposes. The protection of existing landscape quality and diversity becomes the prime importance in the Blue Ridge and Ridges and Valleys of the Basin where these values have remained essentially unchanged.

CHAPTER VI

EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

The previous chapter (Chapter V) outlined the present and projected needs for resource development in the Basin. Chapter VI is devoted primarily to discussion of the contributions of existing USDA projects and programs toward meeting these needs. Contributions of the other public agencies as well as those of the private sector must be considered to provide proper perspective.

Soil and Water Conservation Districts

Understanding of the significance of existing projects and programs toward meeting upstream resource development needs requires discussion of the role and contributions of soil and water conservation districts. The districts are legally constituted units of the State government and are assigned broad responsibility and authority to provide local guidance and coordination for all public and private efforts for the proper use and conservation of land and water resources within their jurisdiction. All counties in the Basin and one independent city (Lynchburg) are currently included in districts.

The original concept of district activities was to assist farm owners and operators in securing technical and financial assistance available through USDA and other programs for land use planning and soil conservation on farms. With the increasing public awareness that changes in one sector can affect all other facets of the total environment, district activities have greatly expanded. On request, they help direct and coordinate the assistance of Federal and State agencies in such areas as watershed protection and flood control, soils interpretation for land use planning, flood hazard studies, erosion and sedimentation control in construction areas, and flood plain zoning and management. As the principal sponsoring and coordinating organization of agricultural and upstream resource projects, they also make substantial contributions to these broader resource projects and programs.

Public Law 566 Programs

Watershed Protection and Flood Prevention

In Virginia "PL-83-566" or "small watershed" projects must be initiated and sponsored by soil and water conservation districts. Other local governmental units may be cosponsors. Usually a project is approved for planning under PL-566 only after a determination has been made that improved land treatment, flood plain management and other non-structural measures will not afford satisfactory solutions to the flood problems.

This program provides the means for local people to utilize assistance available through the SCS with that of other Federal, State and local agencies in planning and project development to meet flood protection and related needs of the watershed. The various agencies inventory the resource potential for meeting objectives. Alternate measures are evaluated with respect to costs and benefits and possible adverse environmental impacts. Needs to be met by the private sector or other non-public groups are considered. Such analysis provides a basis for selection of the most practical and feasible measures to meet the overall demands of the watershed within the limits of the resource potential and with due regard for preservation of the quality of the environment.

The basic element of these projects is proper land use and treatment to reduce erosion and runoff. Reservoirs for temporary storage of floodwaters are the principal structural elements to provide flood protection. Multipurpose use of the floodwater retarding structures frequently afford the least alternate costs to local agencies for meeting needs for water supply, recreation or other uses. Channel improvements sometimes afford the most practical and feasible flood protection in selected stream reaches.

Six projects comprising 429,590 acres are in operation or authorized for installation (Table VI-1). Accelerated planning and application of land treatment measures required under PL-83-566 provides an above-average level of development to meet watershed protection and land management needs in these project areas. Treatment is being applied on about 450 acres of roadsides and other critical erosion areas.

In these six projects, 32 single-purpose retarding structures and two multipurpose (water supply) structures will provide control of floodwaters from 154,585 acres of drainage area. Flood damage reduction and related benefits will be provided on 15,051 acres of flood plains. These structures will provide storage for 6,578 acre-feet of sediment, 41,670 acre-feet for floodwater detention and 1,800 acre-feet for water supply.

Table VI-1 also shows that work plans are being developed on three other watersheds under PL-83-566 and applications have been filed by local sponsors for projects on 12 additional watersheds.

In addition to flood prevention benefits and storage for water supply, the existing projects and those in the active planning stage will make available 2,827 acres in sediment and water supply pools for fishing and other incidental recreation. Fishing and recreational opportunities provided in these pools will depend on public access and management for other uses. One multipurpose structure being developed on Bush River will provide 814 acres specifically for fish and wildlife and recreation.

Table VI-1. Status of existing PL-566 projects, James River Basin

Name of Watershed	CNI Watershed Number	Drainage Area (acres)	Number of Structures	Sediment Pools (acres)	Water Supply Reservoirs (acres)	Recreation Lakes (acres)	Flood Detention (Ac.Ft.)	Sediment (Ac.Ft.)	Water Supply (Ac.Ft.)	Recreation (Ac.Ft.)	Channel Improvement (miles)	Completion Date
INSTALLED OR AUTHORIZED												
Muddy Creek	12-39	7,450	2	19	-	-	870	113	-	-	5.9	1963
Beaver Creek	12b-5	7,010	1	-	104	-	1,760	202	1,600	-	-	1969
Johns Creek	12-18	65,100	4	57	-	-	4,650	325	-	-	17.8	1969
Buffalo Creek	12c-2	74,100	9	20	-	-	9,980	110	-	-	25.5	1969
Willis River	12-45	176,700	11	254	-	-	11,350	2,457	-	-	14.9	1970
Slate River	12-40	98,730	7	180	58	-	13,060	1,940	200	-	9.4	1978
Total		429,950	34	530	162	0	41,670	5,147	1,800	0	73.5	
APPROVED FOR PLANNING												
Buffalo River	12-27	60,500	4	152	678	-	9,630	2,619	4,049	-	-	*
Nibbs Creek	12c-13	16,600	1	-	313	-	2,900	702	2,000	-	-	*
Bush River	12c-4	99,750	8	252	740	814	22,470	3,487	10,000	12,250	-	*
Total		176,850	13	404	1,731	814	35,000	6,808	16,049	12,250		
APPLICATIONS RECEIVED												
Ogle Creek	12-3	29,335	*	*	*	*	*	*	*	*	*	*
Dunlap Creek	12-4,5	77,955	*	*	*	*	*	*	*	*	*	*
Ivy Creek	12-33	23,800	*	*	*	*	*	*	*	*	*	*
Picketts Creek	12-67	5,600	*	*	*	*	*	*	*	*	*	*
Swift River	12b-1	27,850	*	*	*	*	*	*	*	*	*	*
Buck Mountain Creek	12b-3	25,590	*	*	*	*	*	*	*	*	*	*
Stockton Creek	12b-6	14,235	*	*	*	*	*	*	*	*	*	*
Priddy Creek	12b-7	25,340	*	*	*	*	*	*	*	*	*	*
Buck Island Creek	12b-11	22,820 1/	*	*	*	*	*	*	*	*	*	*
Ivy Creek	12b-14	13,835	*	*	*	*	*	*	*	*	*	*
Vaughans Creek	12c-12	17,000	*	*	*	*	*	*	*	*	*	*
Cellar Creek	12c-14	13,000	*	*	*	*	*	*	*	*	*	*
Total		296,360										
Grand Total		903,160										

1/ This portion is a tributary of the CNI watershed listed.

* Not yet determined.

The major significance of these activities is the indication of acceptance by the local people of the PL-83-566 program as a means for substantially meeting needs for water and related land resource development in upstream areas. Almost 1,000,000 acres or about 15 percent of the Basin are included in the 21 projects listed in Table VI-1.

Flood Hazard Analyses

Under this program, SCS can provide technical assistance and cooperate with other agencies and local governing bodies in defining flood hazard areas. No studies have been made to date by USDA agencies in the Basin, but the Virginia Bureau of Water Control Management has estimated that 85 areas need to have the analyses made and that 12 of the localities have an urgent need for the information.

The contribution of this program toward meeting needs of the Basin can be significant. It provides the localities the data needed to assess their flood problems. It focuses their attention on the fallacy of allowing unrestricted development of flood prone areas. As the reports consider future land use and future flood hazards, they also point to the possible need for limiting or regulating development in watersheds above the flood plains. This program can provide factual information, suggest solutions and motivate State and local governing bodies to enact ordinances to regulate land use.

Public Law 46 Programs

This law provided the original authority for establishing the Soil Conservation Service to work with landowners in protecting land resources against soil erosion and for other purposes. Through soil and water conservation districts, SCS furnishes technical assistance to inventory soils according to capability and conservation hazards, and to assist landowners in the planning and application of measures for proper use and management of soil and water resources.

Table VI-2 lists the major practices and units installed in the Basin as of 1968 by cooperating landowners with the technical assistance of the SCS. Comparison with Conservation Needs Inventory data indicates that needed practices have been applied on about 47 percent of the non-Federal forests and farm lands.

SCS personnel employed under this program are responsible for coordination of all Soil Conservation Service activities. They not only plan and schedule technical assistance to individual landowners and groups, but they assist local soil and water conservation districts in obtaining financial and technical assistance available under other programs and help coordinate activities with other agencies.

Table VI-2. Land treatment and structural measures on the land(1968), James River Basin

Practice	Unit	Amount
Conservation Cropping System	acres	364,800
Contour Farming	acres	143,190
Crop Residue Management	acres	155,840
Critical Area Planning	acres	6,625
Diversion	feet	318,070
Drains	feet	4,965,160
Drainage Field Ditch	feet	565,760
Drainage Mains and Laterals	feet	2,210,910
Grassed Waterways	acres	3,950
Irrigation Systems Sprinkler	number	425
Irrigation Storage Reservoirs	number	590
Non-Commercial Recreation Development	number	5,740
Pasture and Hayland Management	acres	255,880
Pasture and Hayland Planting	acres	204,250
Pipelines	feet	323,600
Ponds	number	6,280
Public Recreation Developments	number	85
Spring Developments	number	720
Stripcropping	acres	52,220
Terrace Gradient	feet	1,571,520
Tree Planting	acres	148,053
Trough or tanks	number	1,050
Wildlife Habitat Management	acres	10,040
Wildlife Wetland Management	acres	1,070
Woodland Direct Seeding	acres	10,200
Woodland Improved Harvesting	acres	236,200

Source: Soil Conservation Service 99 Report.

Local SCS personnel provide advisory and coordination services in implementing PL-83-566, Resource Conservation and Development, Flood Hazard Analyses, Flood Insurance Studies and other projects funded under authorities other than PL-46. Other advisory and technical services involve all phases of land and water use and management in urban as well as rural areas.

Resource Conservation and Development Projects

This is another technical and financial assistance program for which SCS has been assigned administrative responsibility. RC&D projects are carried out in similar fashion to watershed protection and flood prevention assistance for land and water use and management to include economics, health, education, recreation or any other

programs which can enhance the general welfare of the people. Currently, no RC&D projects are being developed in the Basin.

The Rural Development Act of 1972 is designed to liberalize and expedite financial and technical assistance to rural communities. The SCS authority to share costs of watershed projects has also been liberalized and extended. The Act should allow still greater contributions under USDA programs.

Economic Research Program

Economic considerations are basic elements of any study or plan for land and water resource development. The Economic Research Service of the USDA cooperates with other public agencies and private businesses in the collection, research and publication of current and projected economic data. ERS personnel are assigned major responsibilities in comprehensive projects such as river basin studies because of the interpretive guidance and broad knowledge they can contribute. These services make a major, though indirect, contribution to the programs of all agencies concerned with resource conservation and development.

Forestry Projects and Programs

National Forest System

The U. S. Forest Service is assigned overall responsibilities relating to all State and private forest lands in comprehensive studies.

The U. S. Forest Service administers two National forests comprising 754,200 acres of publicly owned forest land in the Basin. The major objective of the George Washington and Jefferson National Forests is the promotion of multiple use management.

There are 891 acres of water-based and 83 acres of non-water-based recreation development on the George Washington National Forest. On the Jefferson National Forest there are 680 acres of water-based and 150 acres of non-water-based recreation development. These developments include facilities for boating, fishing, swimming, camping and picnicking.

Grazing is not a practiced use on the George Washington and Jefferson National Forest.

Timber management on the National forests is carried out under the concept of even-aged management. This system allows easier management as well as the coordination of other uses of the forest, ultimately producing a greater variety of useful forest products.

During the ten-year period 1960-70, the George Washington National Forest made harvest and regeneration cuts on 20,000 acres, intermediate cuts on 4,100 acres, and timber stand improvement on 12,500 acres; while the Jefferson National Forest completed harvest and regeneration on 12,700 acres, intermediate cut on 1,600 acres and timber stand improvement on 1,500 acres.

Watershed management programs include erosion control through stabilization of streambanks, roads and trails, gullies and mined areas.

Wildlife is another major use of National forest lands. The Forest Service is cooperating with the Virginia Commission of Game and Inland Fisheries to develop an improved wildlife habitat through employment of forest management techniques. Joint efforts also promote more and better fishing in both streams and reservoirs. The ultimate goal is to produce the optimum annual crop of game consistent with other land use and development activities.

Cooperative State-Federal Forestry Programs

Various General Forestry Assistance Programs are carried out by the Virginia Division of Forestry in cooperation with the U. S. Forest Service. Included are (1) prevention and suppression of forest fires (2) utilization and marketing of timber products (3) marking timber and (4) making tree seedlings available for reforestation. The Cooperative Forest Management Act of 1950 authorized cooperation with State foresters and provide funds on a 50-50 basis for technical services to private forest landowners.

The Weeks Law of 1911 authorized for purchase cutover and denuded forest lands within the watersheds of navigable streams.

The Clarke-McNary Act was passed in 1924. It provides for forest fire control (CM-2), for sale of forest-tree planting stock at low cost (CM-4), and for farm forestry extension work. The assistance to private forest owners is handled by the Virginia Division of Forestry.

The McSweeny-McNary Act, passed in 1928, provided a forest research program for the Nation.

The Forest Pest Control Act of 1947 provides for Federal cooperation to protect and preserve forest resources from destructive forest insect pests and diseases.

The Watershed Protection and Flood Prevention Act (PL-83-566) provides authority to assist local watershed groups in solving water management and flood prevention problems. The Forest Service, in

Lake stocked with trout on Jefferson National Forest.

cooperation with the State foresters, is responsible for making and carrying out the forestry plan and furnishing technical assistance.

The Forestry Incentives Program (FIP) provides for federal cost-sharing to small landowners for the expressed purpose of increasing timber production. In Virginia, the cost-share is 50 percent of the actual cost of performing tree planting and forest management practices.

Under various environmental and conservation programs, financial assistance is provided to private forest landowners to establish and maintain stands of trees for soil protection, forestry and environmental purposes.

Management practices applied to prevent erosion and increase forest products consist of tree planting, reinforcement of existing stands, timber stand improvement, selective cutting, proper harvesting and site preparation. For the ten-year period 1960 to 1970, there were 85,500 acres of timber stand improvement and 142,200 acres of tree planting accomplished on all private and public forest land.

Agricultural Stabilization and Conservation Service

Under the Rural Environmental Conservation Program (RECP) of the Agricultural Stabilization and Conservation Service (ASCS), costs are shared with landowners as an incentive for greater participation in applying soil and water conservation measures. About 50 percent of the farm owners and operators in the Basin participated in the RECP program in 1967. Other services of the ASCS include cropland and production adjustment, conservation reserves and similar programs. The primary results of this program are to provide better vegetative cover conditions in fields and forests and to promote the use of land for purposes for which it is best suited. Advisory and coordination services are contributed to assist in implementation of broader programs as appropriate.

Cooperative Agricultural Extension Service

The Federal-State Extension Service contributes to resource conservation and development primarily through education and information activities. In Virginia, county agricultural agents serve as secretaries of soil and water conservation districts and cooperate in the organization and implementation of PL-83-566 projects and other programs.

The original function of the Extension Service was to demonstrate results of research and to bring new concepts in agricultural production and marketing to farm operators. Today extension agents provide advisory services for coordinating all State programs which can benefit the rural community and assist with coordination of Federal programs.

Farmers Home Administration

Farmers Home Administration (FHA) contributions to resource development serve vital purposes not offered by other agencies or private interests. Loans are made to individual farmers for operation, purchase, enlargement or development. Credit can now be extended to localities for water supply and sewage disposal facilities. These loans sometimes afford the only means for small towns to finance water supply developments. A new provision allows loans for income-producing recreation enterprises.

Under the Rural Development Act of 1972, the FHA's authority to make loans has been extended to small business and rural industry to enhance economic development in rural areas.

Appalachian Program

A plan for the development of water resources in the Appalachian Region has been prepared by the Corps of Engineers as directed by the Appalachian Regional Development Act of 1965. The plan was prepared with Federal, State, local and private agency cooperation. The Appalachian Region is considered to be a rural disadvantaged region and is likely to receive funding priority for future rural development activity.

The Gathright Reservoir, presently being constructed by the COE, is strategically located so as to meet water and related needs of the Alleghany County growth center as well as responding to needs outside the subregion. The project will provide storage for low flow augmentation for water quality control as a supplement to adequate waste treatment at its source. The reservoir will have the capacity to increase low flows by as much as 200 cubic feet per second. Augmentation of the natural flow will improve the quality of the water along 49 miles of the Jackson River and the entire length of the James River below the limits of Appalachia to Richmond. Flood damages will be reduced along the Jackson River and, to a lesser extent, down the James River to Richmond. The 2,530 acre lake with its conservation pool at elevation 1,582 feet and the associated shore areas being planned for development will provide a recreational area for such public activities as camping, picnicking, hiking, nature study and the water oriented sports of fishing, swimming, boating and water skiing. The cold oxygenated water released from the project will provide an environment suitable for trout downstream from the project.

The Appalachian Regional Program Recommended Plan

The water and related land resource needs in the Alleghany County and Botetourt County growth centers are primarily concerned with flood control, maintenance of stream water quality, water supply, industrial, commercial and residential site development and recreation as well as conservation, treatment and management of agricultural and forest lands. Needs of the major downstream cities are water supply and water quality control.

The plan selected for development of the water resources in Appalachian Subregion C would include:

1. Gathright Reservoir, as presently being constructed.

2. Completion of construction of Johns Creek upstream watershed project.

3. Hipes Reservoir to be located on Craig Creek, a tributary of the James.

4. Continued planning on nine upstream watershed improvement projects.

5. Acceleration of land treatment measures of agricultural areas over a ten-year period with priority to the drainage areas above the Gathright and Hipes Reservoirs.

6. Accelerated ten-year program of land treatment measures on National, State and private forest lands with same priority as in (5).

7. Acceleration of two recreation developments in the George Washington and Jefferson National Forests.

8. Flood plain management activities at seven locations to be coordinated in the plan to obtain proper future development of flood plains. Studies at four of these locations are currently in progress and three studies are needed.

9. Studies to formulate a plan for the development of the water resources of the Roanoke River above Roanoke, including water supply for that portion of the metropolitan area in Botetourt County.

Recreation Programs

The administration and funding of recreation developments for the James River Basin can be handled through several methods depending on the construction agency and the various policies involved. Cost-sharing arrangements possible under present laws and policies are shown in Table VI-3. The principal agencies for administration and cost-sharing are: local organizations (as defined in the Watershed Protection and Flood Prevention Act, Public Law 83-566); non-Federal public bodies (as defined in the Federal Water Project Recreation Act, Public Law 89-72); and other agencies having authority under State law.

The emphasis is on non-Federal or local cost-sharing or funding with assistance from the Federal Government where permissible.

Federal assistance can be obtained through such legislation and programs as the Watershed Protection and Flood Prevention Act (Public Law 83-566), the Land and Water Conservation Fund Act of 1965 (Public Law 88-578), the Housing and Urban Development Act of 1965 (Public Law 89-117), the Federal Aid in Fish Restoration Act of 1953 (64 Stat. 430), the Federal Aid in Wildlife Restoration Act of 1937 (50 Stat. 917), and the Federal Water Project Recreation Act (Public Law 89-72). The Federal Water Project Recreation Act can also be implemented in projects authorized prior to January 1, 1966.

The required scale of recreation development throughout the Basin makes fully coordinated development both necessary and desirable for realization of the potential inherent of the Basin's resources.

Water Supply Developments

Several significant municipal and industrial water supply impoundments have been constructed or expanded during recent years. In most instances those reservoirs offer recreational opportunities which are not being used to their full potential (Table VI-4).

Numerous small impoundments throughout the Basin afford significant opportunities for fishing and related recreation. The SCS has developed 6,280 ponds under the PL-46 program. Isaac Walton Clubs and similar organizations have developed other small lakes. Private recreational enterprises include other fishing lakes, usually as an adjunct to swimming pools and other facilities.

The aggregate area of these small impoundments represents approximately 12,000 acres of water surface. An estimated 50 percent of this acreage is adequately managed to afford fishing and related recreation opportunities. These small impoundments meet other needs of the Basin, such as livestock water, fire protection and irrigation.

Table VI-3. Possible administrative and funding arrangements of recreation development under present laws and regulations[1/] James River Basin, Virginia

Construction Agency	Recreation areas to be administered by	Cost sharing or funding of recreation development by
Local organizations (sponsors) under PL-566 with assistance from the SCS	Administration of recreation areas at public recreational developments by local organizations[2/] according to Section 4 of the Watershed Protection and Flood Prevention Act as amended 27 September 1962. Privately owned and operated recreation areas administered by landowners. Administration by U.S. Forest Service when area lies on National Forest land.	Recreation area development costs and modifications of the project for recreation will be shared by local organizations[2/] and the SCS according to Section 4 of PL-566. Some development may be funded by the Land and Water Conservation Fund Act[3/]. Recreation area development funded by landowners. Recreation area development costs funded by U.S. Forest Service.
Corps of Engineers	Administration by non-Federal public bodies[4/] according to PL-89-72 (Federal Water Project Recreation Act) where a cost-sharing and administration agreement has been obtained, unless considered appropriate for Federal administration. Administration by the U.S. Forest Service under terms of 13 August 1964 memorandum of agreement between the Secretary of the Army and the Secretary of Agriculture of those project areas appropriate for administration by the U.S.F.S. as part of a national forest system. Administration of recreation areas at completed projects will be by the Corps of Engineers or other agencies in accordance with the policy provides that recreation areas may be administered by the Corps or leased to non-Federal agencies for such administration.	Funded as project cost but cost shared by non-Federal public bodies[4/] as set forth in PL-89-72 (Federal Water Project Recreation Act) where a cost-sharing and administration agreement has been obtained. Recreation area development funded by the U.S. Forest Service. Existing recreation areas will be funded by the administering agency. Further development of Corps administered areas will be with Code 710 funds, subject to present policy which provides that cost-sharing provisions of PL-89-72 will be applicable after 30 June 1980 at projects under construction before or during FY 1966. All development of new areas not developed at completed projects by FY 1966 nor included in the initial construction will require cost-sharing in accordance with provisions of PL-89-72.
State authorized[5/] Conservation or development District or authority	Administration of recreation areas by the authorized district or authority, or by State or local agencies. Administration of recreation areas by the U.S. Forest Service on National Forest land.	Funding by State or local agencies with cost sharing under provision of Land and Water Conservation Fund Act of 1965. Funding by authorized district or authority cost sharing under provisions of Land and Water Conservation Fund Act of 1965. Recreation area development funded by the U.S.F.S.

See footnotes at end of table.

Table VI-3. Possible administrative and funding arrangements of recreation development under present laws and regulations,[1] James River Basin, Virginia,--Continued

Construction Agency	Recreation areas to be administered by	Cost sharing or funding of recreation development by
U.S. Forest Service	Administration of recreation areas by the U.S. Forest Service on National Forest land.	Recreation area development funded by the U.S. Forest Service. Land acquisition may be financed by the Land and Water Conservation Fund Act of 1965 (PL-88-578) and the Weeks Law of 1911.
State Agencies	State Park System, Park and Recreation Development. State Game and Fish Commission	Funding by State Park System with cost sharing under provisions of the Land and Water Conservation Fund Act of 1965 and Housing and Development Act of 1965. Funding for fishing areas could be under provisions of the Dingell-Johnson Act. Funding for hunting areas could be under provisions of the Pittman-Robertson Act. State funds may also be used for both types of areas.
Local governmental bodies	The administration by local governmental bodies.	Funding by local governmental bodies with cost sharing under provisions of the Land and Water Conservation Fund Act of 1965 and the Housing and Development Act of 1965.

1/ Partial list of existing laws and regulations.

2/ Any state, political subdivision thereof, soil or water conservation district, flood prevention or control district, or combination thereof, or any other agency having authority under State law to carry out, maintain and operate the works of improvement; or any irrigation or reservoir company, water users association, or similar organization having such authority and not being operated for public.

3/ Expansion of initial recreational areas; additional lands may be acquired and/or developed; development of such projects as swimming pools, golf courses, and group campgrounds which are not eligible for small watershed assistance are eligible under the Land and Water Conservation Fund Program.

4/ Non-Federal public bodies - public entities such as States, counties, municipalities, recreation districts or other special-purpose districts with sufficient authority to participate under the provisions of the bill.

5/ Such state authorized agencies as a River Authority or Recreation District.

Table VI-4. Water supply developments, James River Basin

Name	Location	Surface Area (Acres)
Beaver Creek Lake	Albemarle County	100
Diascord Reservoir	New Kent County	1,200
Earlysville Dam	Albemarle County	62
Lake Chesdin	Chesterfield County	
	Dinwiddie County	3,200
Pedlar Lake	Amherst County	
	Albemarle County	100
South Rivanna Reservoir	Albemarle County	390
Swift Creek Reservoir	Chesterfield County	1,700
Total		7,627

CHAPTER VII

WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

Chapters II and III of this report describe the natural resources and the economic base of the Basin. Chapter IV is a discussion of the water and land resource problems. In Chapter V these problems were translated into present and future needs. Chapter VI describes the contributions of existing projects and programs toward meeting the resource needs.

This chapter (Chapter VII) presents an assessment of the physical potential for resource development in the Basin to meet the needs and wants of the people. The total potential must necessarily be considered but the emphasis is on the potential for resource development under USDA and related programs.

Availability of Land for Potential Development

Land will not be a limiting factor in resource development if reasonable care is exercised in adapting use to land capability (Appendix A). About 2.7 acres per capita will be available to meet needs for living space and other demands for the projected population in 2020.

The area of the Basin is about 6.4 million acres. In 1967, 7.3 percent was occupied by water, independent cities, suburbs, and other built-up areas (Table VII-1). About 12 percent will be used for these purposes in 2020. The approximately six million acres available in 1967 for production of food and fiber, outdoor recreation, and related needs will be reduced to about 5.7 million acres or about 2.4 acres per capita for the projected population in 2020.

As shown in Table VII-1, estimates for 2020 indicate that farm and forest acreage in land capability classes I through IV will still comprise 3.13 million acres or 48.6 percent of the total Basin. This would allow a wide range for adapting cultivated crops to land use and capability for meeting food and fiber needs. Two and one-half million acres of farm and forest land will be in land capability classes V thru VIII. These areas will be available for pasture, forest, wildlife, and other limited uses. These data, related to projected conversions and use, indicate an excellent potential for adapting farm and forest uses to proper land capability.

Lands in capability classes I and II are best adapted to cropland. Reduced erosion and runoff and more efficient production result

Table VII-1. Acreage and percent by land capability class by year, James River Basin

	Land Capability Class	1967[1/] Acres (1000)	1967[1/] Percent	2020[2/] Acres (1000)	2020[2/] Percent
Agricultural, Forest land, and other lands[3/]	I	75.0	1.2	71.0	1.1
	II	1440.1	22.3	1364.0	21.2
	III	1143.1	17.7	1082.6	16.8
	IV	649.8	10.1	615.4	9.5
	Subtotal I-IV	3308.0	51.3	3133.2	48.6
	V	49.2	.8	49.2	.8
	VI	1062.4	16.5	1006.2	15.6
	VII	1525.1	23.7	1444.5	22.4
	VIII	25.5	.4	25.5	.4
	Subtotal V-VIII	2662.2	41.4	2525.4	39.2
	Total	5970.2	92.7	5658.6	87.8
Urban and Built-Up		295.3	4.6	579.8	9.0
Total Land Area		6265.5	97.3	6238.4	96.7
Water Area		176.9	2.7	204.0	3.2
Total Basin Area		6442.4	100.0	6442.4	100.0

1/ From hydrologic boundaries of 1967 Conservation Needs Inventory Subwatersheds - varies slightly from ERS data which was compiled using generalized county boundaries.

2/ Proportional to ERS projections except an estimate of the increase in water acreage was included.

3/ Other lands defined in Appendix D.

when cropland is restricted to soils with few limitations and no severe conservation hazards. In 2020, 1.4 million acres of class I and II land will still be available with only 261,500 acres expected to be used for cropland. This would allow all cropland to be shifted to these class I and class II soils. Also the 287,400 acres of class III and class IV lands and the 65,100 acres of class VI and class VII lands now in cropland (Table II-3) could be converted to less hazardous uses such as pasture or forest land. An approximate 300,000 acreage reduction in pasture and 200,000 acreage increase in forest land by 2020 will also provide greater potential for adapting land use to capabilities.

About 300,000 acres will be converted to industrial, urban, and built-up areas by 2020. Table IV-7 shows that about 31 percent of the gross erosion occurs in urban areas and most of this occurs in construction areas where soil is extremely vulnerable to erosion. The potential is great for adapting USDA erosion control techniques and practices in these construction areas.

With judicious use and management of land resources, the increased per acre yields will aid in meeting food and fiber needs. These and other efficiencies will allow more discretion in land use options for preservation and enhancement of scenic, wildlife, and other environmental values. A full discussion of the Basin's potential for meeting recreational and related environmental needs is included in the Outdoor Recreation Report prepared by the Bureau of Outdoor Recreation. A summary discussion of this material is presented in the "Potential Recreation Supply" section of this chapter.

Impoundments

Numerous suitable dam sites, coupled with average annual water yields ranging from 11 to 20 inches, provide a great potential for water resource development. Impoundments in upstream watersheds can alleviate the problems of flood damage and rural water supply and help meet the needs for municipal and industrial water supply, water-related recreation, and fish and wildlife enhancement. In addition, small impoundment sites are available to meet needs for livestock, irrigation, recreation, and other uses.

Reservoir Storage Potential

Five hundred and eighty-seven sites were determined to have physical potential for development to meet upstream storage needs

under PL-566 limits on structure size.[1/] Table VII-2 lists these sites by watershed and subarea with estimated allocation for flood and sediment storage and remaining beneficial storage available. Table VII-3 lists specific sites which appear to have outstanding storage potential either for single or multipurpose development to include water supply, recreation, or other uses. Chapter VIII provides more detailed data for those sites which appear to be economically feasible under PL-566. Other data on location and storage potential of specific sites are available in Soil Conservation Service files.

An estimated additional 10,000 smaller sites have water storage potential for livestock, irrigation, family-type recreation, and similar uses. Technical assistance is available through going programs for selection and development of these sites. The total of these and the medium-sized sites (Table VII-2) indicates an aggregate potential for about 4 million acre-feet of storage.

Development of each site for the sole purpose of providing water surface could supply about 150,000 acres in fresh water reservoirs. Assuming that priorities for other purposes will prevail, these sites would still afford an estimated potential 50,000 acres of water surface to meet recreation or other needs in single or multipurpose structures. For this potential to be realized, appropriate public access and proper management must be provided.

Land Rights Situation

The responsibility for obtaining necessary easements for watershed projects rests with the local sponsoring organizations. On private land, easements are generally obtained on a voluntary basis from individual landowners. The ease or difficulty with which land rights can be obtained varies from one locality to another and depends to a great extent on the project purposes and benefits.

In the past, failure to gain necessary easements has delayed and even curtailed a number of watershed projects. Land rights acquisitions must keep ahead of project planning and development to insure that land is available for potential impoundments.

1/ Reservoir size under PL-566 is currently limited to 12,500 acre-feet for flood detention purposes and 25,000 acre-feet total. Tables VII-2 and VII-3 include several sites in which it would not appear practical to hold to these limits.

Table VII-2. Reservoir storage potential, James River Basin

CNI Watershed No.	Watershed Name	W/S Drainage Area (Sq.Mi.)	Number of Pot. Sites	D.A. Above Sites (Sq. Mi)	Storage Potential by Purpose: Flood & Sediment (In.)	Flood & Sediment (Ac.Ft.)	Beneficial[2/] (In.)	Beneficial[2/] (Ac.Ft.)	Total (In.)	Total (Ac.Ft.)	Surface Area[1/] (Ac.)
	RIDGES AND VALLEYS PHYSIOGRAPHIC PROVINCE										
12-1	Back Creek	140.8	9	81.2	3.4	14,725	15.8	68,425	19.2	83,150	1,600
12-2	Jackson River 3	44.8	Gaithright Dam - Corps of Engineers								
12-3	Ogle Creek	45.8	7	33.7	4.0	7,190	14.4	28,875	18.4	33,065	600
12-4,5	Dunlap Creek	121.8	8	43.7	4.0	9,325	11.7	27,275	15.7	36,300	600
12-6,7	Jackson R., 1,2	156.5	10	60.9	4.1	13,315	14.4	46,770	18.5	6,085	1,300
12-8	Jackson R., 4	98.4	11	55.2	4.3	12,660	14.4	42,395	18.7	55,055	1,400
12-9,10,11	Potts Creek	173.3	13	121.1	4.0	25,835	14.4	93,100	18.4	118,845	1,400
12-12,13,14	Cowpasture R.	464.3	45	252.4	3.6	48,460	14.0	188,455	17.0	236,915	6,100
12-15	Jackson R., 5	114.4	8	60.9	4.1	13,315	14.0	45,470	18.1	58,785	1,000
12-16	James R., 1	86.4	9	47.6	3.9	9,900	13.5	34,275	17.4	44,175	1,100
12-17	Craig Creek , 2	154.6	10	77.7	3.7	15,335	14.0	58,015	17.7	73,350	1,900
12-18	Johns Creek	101.6	P.L. 566 Work Plan Authorized								
12-19	Craigs Creek 1	113.1	14	67.8	3.7	13,380	14.0	50,625	17.7	64,005	1,600
12-20	James River 3	141.8	11	35.1	3.9	7,300	13.0	25,270	17.4	32,570	700
12-21	James River 2	127.6	16	60.6	4.3	13,900	13.5	43,630	17.8	57,530	2,000
12-22	Catawba Creek	115.3	12	60.4	5.1	16,425	13.0	41,875	18.1	58,300	1,400
12a-1	Calfpasture River	186.4	12	64.6	4.0	13,780	13.0	44,785	17.0	50,565	1,140
12a-2	Little Calfpasture	132.7	4	93.0	4.6	22,815	13.0	64,480	17.6	87,295	2,790
12a-3	Mays Creek	95.8	6	74.1	5.2	20,550	13.0	51,375	18.2	71,925	1,900
12a-4	Maury River	156.0	8	27.3	5.2	7,570	13.0	18,930	18.2	26,900	790
12a-5	Buffalo River	148.7	19	84.2	5.2	23,355	13.0	58,385	18.2	81,740	1,490
12a-6	South River	118.8	13	69.4	6.3	23,315	13.0	48,115	19.3	71,430	1,500
	Sub Total	3038.9	245	1470.9		332,450		1,077,435		1,409,885	33,130
	BLUE RIDGE AND PIEDMONT PHYSIOGRAPHIC PROVINCE										
12-23,24	Rockfish River	247.3	14	116.1	5.9	36,535	16.6	102,785	22.5	139,320	3,980
12-25	Tye River	134.9	6	67.2	5.6	20,070	19.4	69,530	25.0	89,600	1,680
12-26	Piney River	70.4	5	42.1	5.7	12,800	19.8	44,455	25.5	57,755	1,220
12-27	Buffalo River	154.8	P. L. 566 Work Plan Authorized								
12-28	Pedlar River	107.6	9	60.3	5.7	18,330	12.6	40,520	18.3	58,850	2,340
12-29	James River 4	131.9	5	34.0	5.1	9,250	12.6	22,850	17.7	32,100	980
12-30	Hardware River	138.0	10	57.1	6.2	18,880	12.6	38,370	18.8	57,250	2,760
12-31	Rucker Run	58.7	5	36.3	5.1	9,875	12.6	24,395	17.7	34,270	1,260
12-32	Harris Creek	48.4	5	26.5	6.0	8,480	12.6	17,810	18.6	26,290	1,060
12-33	Ivy Creek	37.2	6	27.3	5.5	8,010	12.6	18,345	18.1	26,355	1,070
12-34	James River 7	116.9	6	58.7	5.2	16,280	12.6	39,445	17.8	55,725	2,600
12-35	James River 6	141.3	14	82.2	5.2	22,795	12.6	55,240	17.8	78,035	2,490
12-36	James River 5	151.3	12	59.0	5.2	16,360	12.6	39,650	17.8	56,010	2,000
12-37	James River 8	98.3	8	44.3	5.3	12,520	12.6	29,770	17.9	42,290	2,170
12-38	Slate River 2	78.4	7	29.6	4.8	7,580	11.7	18,470	16.5	26,050	1,310

See footnotes at end of table.

Table VII-2. Reservoir storage potential, James River Basin--Continued

CNI Watershed No.	Watershed Name	W/S Drainage Area (Sq. Mi.)	Number of Pot. Sites	D.A. Above Sites (Sq. Mi.)	Storage Potential by Purpose: Flood & Sediment (In.)	Flood & Sediment (Ac.Ft.)	Beneficial[2/] (In.)	Beneficial[2/] (Ac.Ft.)	Total (In.)	Total (Ac.Ft.)	Surface Area[1/] (Ac.)
12-39	Muddy Creek	11.6	P. L. 566 Work Plan Authorized								
12-40	Slate River 1	155.3	P. L. 566 Work Plan Authorized								
12-41	Bent Creek	31.0	3	19.2	5.2	5,325	12.6	12,900	17.8	18,225	680
12-42	Wreck Island Cr.	58.3	10	36.8	5.2	10,205	12.6	24,730	17.8	34,935	1,400
12-43	Beaver Creek	37.0	6	31.5	5.2	8,710	12.6	21,100	17.8	29,810	620
12-44	Byrd Creek	117.3	8	48.7	4.7	12,025	12.2	31,685	16.9	43,890	2,630
12-45	Willis River	267.1	P. L. 566 Work Plan Authorized								
12-46	Lickinghole Creek	72.2	5	60.8	4.7	15,240	12.2	39,560	16.9	54,800	3,710
12-47	James River 9	73.1	8	20.0	4.7	5,015	11.7	12,480	16.4	17,495	1,060
12-48	Muddy Creek	40.9	4	29.4	4.7	7,370	11.7	18,345	16.4	25,715	1,490
12-49	Deep Creek	83.4	5	33.4	4.7	8,370	11.7	20,840	16.4	29,210	1,240
12-50	Beaverdam Creek	40.1	3	30.4	4.7	7,620	11.7	18,970	16.4	26,590	1,610
12-51	James River 10	121.1	8	51.3	4.3	11,765	11.7	32,010	16.0	43,775	2,640
12b-1,2,7,12	No.Fork Rivanna R.	177.3	22	133.2	6.4	45,465	12.6	89,510	19.0	134,975	5,960
12b-3,4,5,6, 13,14	S. Fork Rivanna R.	266.8	25	217.4	6.3	69,070	12.6	146,080	18.9	215,160	7,600
12b-8	Rivanna River 1	58.8	3	16.6	6.6	5,845	12.6	11,155	19.2	17,000	780
12b-9	Mechunk Creek	62.8	4	16.4	6.6	5,775	12.6	11,020	19.2	16,795	1,000
12b-10	Rivanna River 2	71.1	6	42.9	6.1	13,955	12.6	28,830	18.7	42,785	1,870
12b-11	Rivanna R. 3	131.9	13	92.0	6.1	29,930	12.6	61,825	18.7	91,755	4,120
12c-1,2,12	U. Appomattox R.	303.2	12	215.0	4.6	52,745	11.2	128,425	15.8	181,170	7,000
12c-3,4	M. Appomattox R.	336.2	21	247.5	4.6	60,720	11.7	154,440	16.3	215,160	11,000
12c-5,8	L. Appomattox R.	250.4	10	87.0	4.6	21,345	10.8	50,110	15.4	71,455	5,050
12c-6,9,13, 14	Flat Ck-Deep Ck.	356.1	23	259.8	4.5	62,350	10.8	149,645	15.3	211,995	11,000
12c-10	Namozine Creek	63.5	3	24.1	4.5	5,785	10.8	13,830	15.3	19,665	1,000
12c-66	Blackwater Ck.	28.4	1	19.2	5.5	5,630	12.6	12,900	13.1	18,530	700
12c-67	Pickett Creek	8.8	P. L. 566 Work Plan Authorized								
	Sub Total	4,948.1	315	2,473.2		683,205		1,652,035		2,340,290	103,210
	COASTAL PLAIN PHYSIOGRAPHIC PROVINCE										
12-52	Tuckahoe Creek	63.0	1	8.8	4.6	2,160	11.7	5,490	16.3	7,650	540
12-53	Chickahominy R.1	1,112.2	2	18.5	4.6	4,540	12.6	12,430	17.3	16,970	1,200
12-54	James River 11	97.9	0[3/]								
12-55	Falling Creek	60.5	3	21.4	4.6	5,250	11.7	13,355	16.3	18,605	1,150
12-56	Chickahominy R. 2	127.8	6	15.0	4.6	3,680	12.6	10,000	17.2	13,700	1,050
12-57	James River 12	142.6	1	2.2	4.6	540	11.7	1,370	16.3	1,910	350
12-58	Chickahominy R. 3	218.7	2	9.1	4.6	2,230	12.6	6,115	17.2	8,845	700
12-59	James River 13	102.1	1	3.8	4.6	930	10.8	2,100	15.4	3,120	190
12-60	James River 14	175.7	3	10.7	4.6	2,625	10.8	6,165	15.4	8,790	570
12-61	James River 15	72.9	0								

See footnotes at end of table.

Table VII-2. Reservoir storage potential, James River Basin--Continued

CNI Watershed No.	Watershed Name	W/S Drainage Area (Sq. Mi.)	Number of Pot. Sites	D.A. Above Sites (Sq. Mi.)	Storage Potential by Purpose: Flood & Sediment (In.)	Flood & Sediment (Ac.Ft.)	Beneficial 2/ (In.)	Beneficial 2/ (Ac.Ft.)	Total (In.)	Total (Ac.Ft.)	Surface Area 1/ (Ac.)
12-62	James River 16	117.5	0								
12-63	James River 17	119.9	0								
12-64	James River 18	147.6	2	14.7	4.6	3,605	9.9	7,760	14.5	11,365	900
12-65	Nansemond River	204.8	0								
12c-7	Swift Creek	183.1	5	37.0	4.5	8,880	10.8	21,310	15.3	30,100	1
12c-11	Appomattox R. 5	132.9	1	9.9	4.5	2,375	10.8	5,700	15.3	8,075	
	Sub Total	2,079.2	27	151.1		36,815		91,965		128,780	6,651
JAMES RIVER BASIN TOTAL		10,066.2	587	4,095.2		1,057,470		2,821,485		3,878,955	142,991

1/ Surface area at elevation of emergency spillway.

2/ Based on percentage of average annual watershed yield used in North Atlantic Water Resources Study.

3/ Indicates no potential sites within the framework of the Basin study. These watersheds do have potential for farm ponds and other small impoundments.

Table VII-3. Outstanding storage potential sites, James River Basin

Physiographic Province CNI Watershed Number and County	Site Number	Stream Name	Drainage Area (Sq. Mi.)	Storage: Flood[1] Prevention (Ac. Ft.)	Storage: Beneficial[2] (Ac. Ft.)	Surface Area[3] (Ac.)
Ridges and Valleys						
12-6 Highland	1G[4]	Jackson River	43.0	9,160	23,000	640
12-10 Alleghany	6 [4]	Mill Branch	7.3	1,670	3,900	130
12-11 Monroe, W. Va.	1A[4]	Potts Creek	30.5	6,660	4,700	450
12-12 Highland	1B[4]	Bullpasture River	71.2	10,800	31,300	1280
12-22 Botetourt	7 [4]	Borden Creek	5.3	1,400	2,800	160
12a-1 Augusta	1 [4]	Calfpasture River	11.6	2,530	6,200	250
12a-2 Rockbridge	2	Little Calfpasture River	54.8	11,810	38,000	1180
12a-3 Rockbridge	6B	Hays Creek	48.3	13,450	33,450	1440
12a-5 Rockbridge	11B	Buffalo Creek	52.7	14,620	36,500	1060
Blue Ridge & Piedmont						
12-23 Nelson	2 [4]	Perry Creek	7.0	2,280	3,700	260
12-23 Nelson	3 [4]	Taylor Creek	7.1	2,290	3,800	200
12-24 Nelson	1 [4]	So. Fork Rockfish River	34.6	10,600	17,400	840
12-25 Nelson	4 [4]	Hat Creek	11.5	3,540	6,100	300
12-26 Amherst	3 [4]	Indian Creek	7.3	2,270	3,900	200
12-30 Albemarle	2A[4]	Middle Branch	6.2	2,050	3,300	260
12-30 Albemarle	4 [4]	So. Fork Hardware River	11.6	3,820	6,200	420
12-31 Albemarle	1A	Rucker Run	25.4	6,910	17,100	810
12-33 Bedford	1A	Ivy Creek	24.0	7,040	16,100	860
12-34 Albemarle	4A	Totier Creek	28.0	7,760	18,800	1420
12-35 Buckingham	1C	David Creek	41.1	11,400	27,600	1750
12-41 Appomattox	1A[4]	Bent Creek	10.3	2,860	5,500	350
12-42 Appomattox	1A	Wreck Island Creek	18.5	5,130	12,400	630
12-42 Appomattox	3 [4]	North Creek	12.3	3,390	6,600	450
12-43 Campbell	4	Beaver Creek	20.7	5,740	13,900	640
12-44 Fluvanna	3 [4]	Little Byrd Creek	12.9	3,240	6,900	440
12-44 Goochland	8	Little Byrd Creek	11.9	2,980	7,700	620
12-46 Goochland	1B	Lickinghole Creek	31.5	7,900	20,500	1560
12-46 Goochland	2A	Little Lickinghole Creek	27.0	6,770	17,600	1240
12-48 Powhatan	1	Muddy Creek	15.7	3,930	9,800	780
12-49 Cumberland	1A	Deep Creek	26.8	6,720	16,700	1180
12-50 Goochland	1A[4]	Beaverdam Creek	16.4	4,080	8,800	810
12-66 Campbell	7	Blackwater Creek	19.2	5,630	12,900	680
12-28 Amherst	7	Horsely Branch	8.0	2,430	5,380	280
12b-3 Albemarle	5C	Ivy Creek	24.7	8,300	16,600	1020
12b-4 Albemarle	1C	Moormans River	31.8	10,680	21,400	1280
12b-6 Albemarle	1B	Mechum River	34.5	11,590	23,200	1150
12b-6 Albemarle	4B[4]	Stockton Fork	21.5	7,580	11,500	580
12b-8 Albemarle	4A	Biscuit Run	12.4	4,360	8,300	560
12b-10 Albemarle	8A	Buck Island Creek	31.0	10,080	20,800	1560

See footnotes at end of table.

Table VII-3. Outstanding storage potential sites, James River Basin--Continued

Physiographic Province CNI Watershed Number and County	Site Number	Stream Name	Drainage Area (Sq. Mi.)	Storage: Flood 1/ Prevention (Ac.Ft.)	Storage: Beneficial 2/ (Ac.Ft.)	Surface Area 3/ (Ac.)
Blue Ridge and Piedmont (Cont.)						
12b-11 Fluvanna	7B	Cunningham Creek	31.1	10,120	20,900	1250
12b-11 Fluvanna	8	Ballinger Creek	17.2	5,590	11,600	590
12c-11 Appomattox	4A 4/	Appomattox River	46.2	11,440	24,600	1210
12c-3 Amelia	7	Sandy Creek	8.6	2,110	5,400	480
12c-3 Cumberland	11B 4/	Big Guinea Creek	29.8	7,240	15,900	1320
12c-4 Prince Edward	1C 4/	Bush River	59.0	14,100	31,500	2200
12c-4 Prince Edward	4B	Briery Creek	36.5	8,960	22,800	1460
12c-4 Prince Edward	5B 4/	Sandy River	36.2	8,760	19,300	1390
12c-5 Powhatan	1A	Fighting Creek	23.4	5,740	13,500	1570
12c-5 Powhatan - Chesterfield	4	Skinquarter Creek	11.5	2,820	6,500	700
12c-6 Amelia	1C	Flat Creek	75.0	18,000	43,200	1540
12c-6 Amelia	6	Nibbs Creek	14.4	3,460	8,300	480
12c-8 Chesterfield	3	Winterpock Creek	20.2	4,950	11,600	1090
12c-9 Nottoway	1B 4/	Deep Creek	43.4	10,360	23,200	2060
12c-9 Nottoway	3	Woody Creek	13.3	3,190	7,700	690
12c-9 Amelia	8	West Creek	15.5	3,720	8,900	710
12c-10 Amelia & Dinwiddie	1	Namozine Creek	18.9	4,540	10,900	970
Coastal Plain						
12-53 Henrico	1	Chickahominy River	15.1	3,700	10,100	1120
12-55 Chesterfield	1A	Falling Creek	16.8	4,120	10,500	860
12-64 Isle of Wight	2	Champion Swamp	12.2	2,990	6,400	750
12c-7 Chesterfield	5	Second Branch	12.7	3,050	7,300	800
12c-11 Dinwiddie	1	Whipponock	9.9	2,380	5,700	600

1/ Includes Sediment and Flood Detention Storage
2/ Beneficial storage based on same criteria used in Table VII-2.
3/ Surface area at crest of emergency spillway.
4/ These sites are included in Watershed Investigation Reports for potentially feasible P. L. 566 projects.

Location and Distribution

Distribution of potential impoundments within the physiographic provinces is fairly uniform. Refer to Figure 1 for location of specific watersheds and to Table VII-2 for the number of potential sites.

Ground Water Potential

In the Appalachia region of the Ridges and Valleys the optimum amount of ground water that may be developed is 25,000 to 250,000 gallons per day per square mile.[1/] This type of data is not yet available for other areas of the Basin, but 250,000 gpd per square mile appears to be a very conservative estimate of optimum development potential of ground water throughout the Basin. For the total Basin this equals 91,600 million gallons per year.

The primary use of ground water in upstream watersheds is for rural domestic supply. The projected demand for rural farm and rural non-farm use in the year 2020 is about 32,300 million gallons (Table V-7). This indicates that the ground water potential is more than adequate for these needs and that supplies would be available in most areas for rural industry or rural residential developments with limited water requirements. Careful study would be warranted in potentially high yield areas where ground water may be a more economical source than surface water for industry with moderate to high water requirements. Experience indicates that development of ground water resources for irrigation will not be economically feasible in the foreseeable future.

Channel Improvements and Levees

The use of channel improvements and levees for flood prevention in upstream watersheds has limited potential except in combination with floodwater retarding structures.

In the Ridges and Valleys, flood plains are relatively narrow. The banks of the channels are usually three feet or less in height. Bedrock, exposed in the channels, controls the stream gradient and limits depth. Consequently, in order to obtain required capacities, channel widths would increase beyond practical limits. The problem of meander during low flows would also be aggravated.

1/ Development of Water Resources in Appalachia, Appendix H, prepared by U.S. Dept. of Interior Geological Survey. This publication includes the note: "In most counties the optimum amount shown is between 25 percent and 50 percent of the maximum available under existing natural conditions."

In the Piedmont, flood plains average about 600 feet in width. The banks of the channels are higher, generally six feet or more. In the northern Piedmont, bedrock in the channels controls the gradient of the stream and limits depth. In the southern Piedmont and on the Coastal Plain, the limited gradient of the streams is the controlling factor. Throughout the Basin, encroachment of urban development increases the complexity of the choice of structural measures for flood prevention. Flood prevention dams in combination with limited channel improvement can provide an adequate degree of protection to agricultural lands in some watersheds. Floodwalls or levees can give added protection to urban areas.

Irrigation Potential

One of the technological improvements which could be used to increase the share of food and fiber demands met locally is irrigation. The following analysis roughly indicates the potential of irrigation in the James River Basin. The objective of the following analysis is to provide estimates of the acres of irrigation necessary to meet Basin demands in light of historical practices and continuation of the provision of regional share of food and fiber.

Data for irrigated cropland was obtained from the Census of Agriculture for 1954, 1959, and 1969. These data are presented in Table VII-4.

Irrigation projections, based on historical trends, made by the North Atlantic Regional Water Resources Study are presented in Graph 6. Their regional delineation of the James River Basin varies slightly from the delineation used in this report.1/ Nevertheless, their projection of the acres irrigated in 1969 grossly overestimated the 1,700 acres which did occur. This does not mean, however, that the rest of their projections are overestimates. There are numerous problems associated with a simple linear projection. The underlying forces behind increasing adoption of irrigation are largely ignored. Ideally, such a projection would be improved if the effect of these forces, both positive and negative, could be identified and included in the method of projection. One of the obvious forces is weather. Table VII-5 illustrates how rainfall has varied during a given period of time and between time periods. Assuming that adoption

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1/ The region used by the North Atlantic Regional Water Resources Study includes the additional counties of Nansemond, Norfolk, Princess Anne, Warwick and Elizabeth City, Virginia.

Table VII-4. Acreage of irrigated land, by year, James River Basin

Subregion and County	1954	1959	1964	1969
	Acres			
Subregion 1				
Alleghany	0	50	20	35
Bath	0	0	18	45
Botetourt	608	498	300	162
Craig	0	69	5	0
Highland	0	20	38	0
Rockbridge	0	34	89	1
Total	608	671	470	243
Subregion 2				
Albemarle	762	591	663	119
Amelia	189	308	668	347
Amherst	2	132	131	62
Appomattox	116	153	251	182
Buckingham	3	2	154	12
Cumberland	1	0	15	4
Fluvanna	67	77	190	42
Goochland	507	357	106	12
Greene	0	0	54	0
Nelson	25	243	295	85
Nottoway	107	173	383	139
Powhatan	195	6	38	4
Prince Edward	42	40	281	83
Total	2,116	2,082	3,228	1,091
Subregion 3				
Charles City	88	28	10	10
Chesterfield	240	82	148	37
Henrico	472	350	57	56
Isle of Wight	47	52	111	168
James City	616	255	151	0
New Kent	105	73	21	10
Prince George	48	87	148	19
Surry	0	0	0	27
Total	1,616	927	646	327
Basin Total	4,340	3,680	4,344	1,661

Source: Census of Agriculture

Change 1954 - 59	660 acres	15% decrease
Change 1959 - 64	664 acres	18% increase
Change 1964- 69	2,683 acres	61% decrease

Mean of 4 years: 3,506 acres

Graph 6. Acres of irrigated land, by year, James River Basin, Virginia

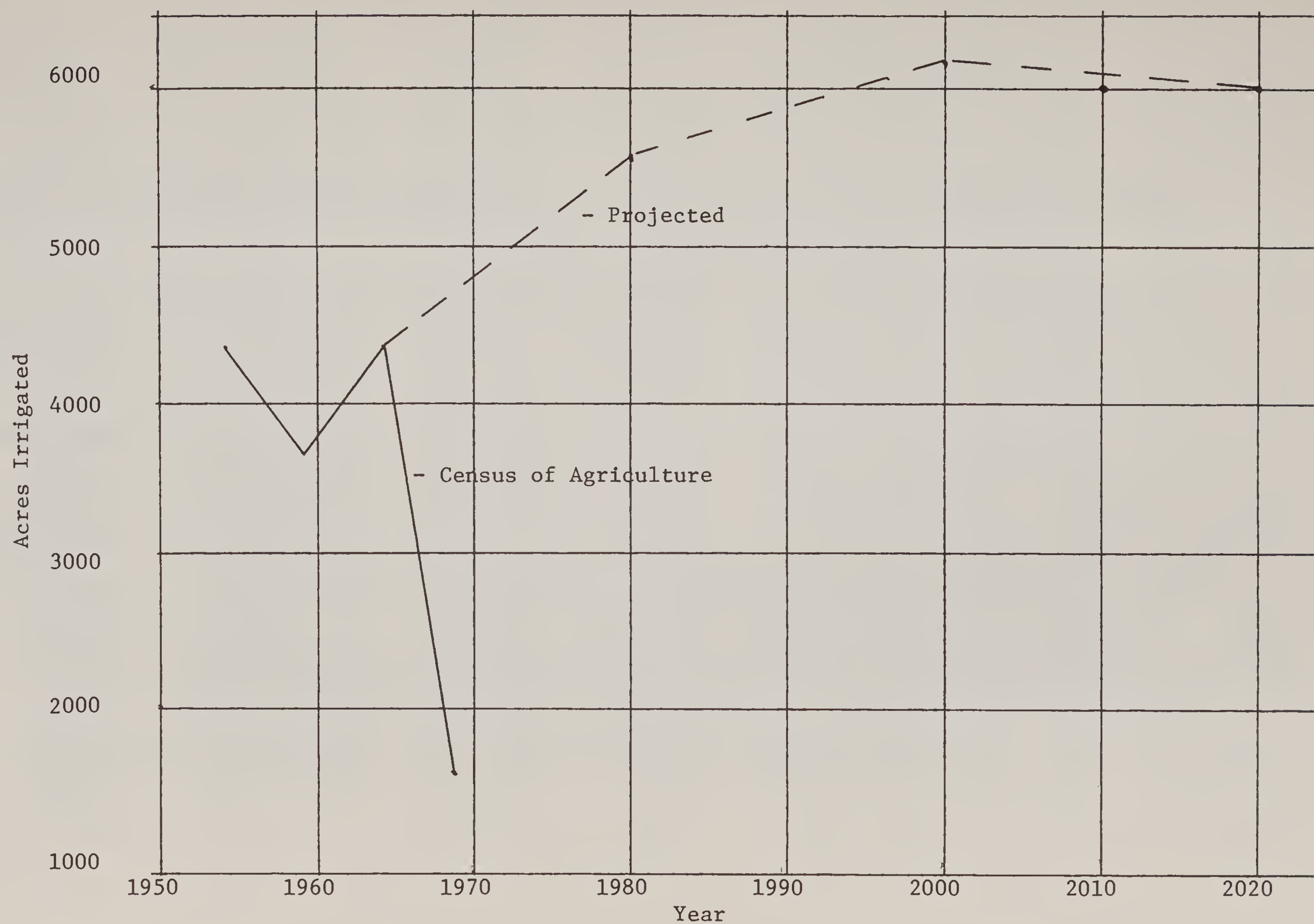

Table VII-5. Mean seven-month precipitation and seven-month precipitation for 1954, 1959 and 1964 for selected weather stations, James River Basin 1/

Station	Seven-Month Precipitation Mean	Seven-Month Precipitation 1954	Deviation from Mean	Seven-Month Precipitation 1959	Deviation from Mean	Seven-Month Precipitation 1964	Deviation from Mean
	Inches						
Virginia							
Covington	20.40	26.47	+6.07	25.96	+5.56	15.36	-5.04
Lynchburg	24.57	20.02	-4.55	25.52	+0.95	15.86	-8.71
Charlottesville	29.07	22.90	-6.17	34.91	-5.84	24.06	-5.01
Richmond	27.69	19.46	-8.23	35.36	+7.67	28.77	+1.08
Williamsburg	30.46	20.57	-9.89	30.82	+0.36	27.35	+3.11

1/ Seven-months: April, May, June, July, August, September and October

Source: Climatological Data for Virginia, U. S. Weather Bureau, U. S. Department of Commerce

of irrigation tends to accelerate in dry years and slack off in normal or wet years, one could conclude that acreage irrigated in 1954 and 1964 may be above the long run trend. However, many factors such as interregional competition and changing technology also influence the trend as well as weather. Such forces have been very important in the recent past and can be expected to continue to play a major role in shaping future agriculture.

Considering only irrigation, with all other technological development held constant, the efficiencies inland use which can be gained through its application can reduce some of the pressure on the land resource base. The Basin will be able to supply its needs without additional irrigation until approximately 1990. By the year 2020, the deficit in cropland acres needed will have grown to 223,264 acres. Assuming a 25 percent irrigation efficiency rate, the Basin will be able to meet its projected regional share of production with additional irrigated acreage in the amount of 54.7[1/] thousand acres in 2000 and 167.4 thousand acres in 2020. Assuming a 50 percent irrigation efficiency rate, additional irrigated acreage will be needed in the amount of 36.5 thousand acres in 2000 and 111.6 thousand acres in 2020.

Caution must be followed in the use of this data since areas outside the Basin may be able to produce more efficiently. The historical decline of acres harvested in spite of increasing regional needs substantiates the comparative advantage of outside areas.

If irrigation is to be used to increase production of food and fiber in the Basin, irrigation water demands must be recognized when planning upstream and main stem projects. The degree to which irrigation water demand is going to be allowed to compete with other water uses must be decided for each project and for all projects in combination.

The analysis of irrigation development to meet regional needs shows one possible way to maintain viable agriculture within the Basin. Investment in drainage, flood protection measures, and management are alternatives which would also allow greater production from a given resource base. Expected returns from these alternative investments are needed in order to assess the possible contribution of such investments and to compare with irrigation.

1/ A more detailed description of the analysis used in this section is available in The Base for Development; James River Basin, Virginia, NRED, Economic Research Service, USDA, Upper Darby, Pa., August, 1973.

Potential for Increasing Forest Products

One way to supply markets for timber products is to look to foreign sources. Net imports now make up about 12 percent of the wood products consumed nationally. In future years, Canada, now harvesting about a third of their potential allowable harvest, could supply the U. S. with increasing volumes of lumber as well as pulp and newsprint. The U. S. could look to tropical countries to supply most of our increased demands for hardwood plywood, veneer, and lumber.

Another alternative is to make better use of timber supplies that are available. Industry has made good progress in utilizing the residue of manufacturing and in reducing the volume of unused material left in the woods after logging. But much more could be done through industrial application of better technology and market development. Modernization of many plants would permit increased recovery of lumber from available logs. Better sorting of material to insure the best end use would also help stretch saw log supplies. Development of structural particle boards could have the effect of supplementing supplies of veneer logs.

Another method of increasing the supply of forest products is to increase the acres of land devoted to forest productions. It has been estimated elsewhere in this report that 265,000 acres of land in other uses in 1965 will become forest land by 1980. Table II-3 indicates there are 69,000 acres of cropland and 233,600 acres of pasture in land capability classes V thru VIII which may revert to forest land. On the other hand, there are 2,097,100 acres of forest land in land capability classes I thru IV which may be used for cropland or pasture if the demand for agricultural land becomes great enough to warrant conversion. The conversion of agricultural land (or any other land) to forest land to alleviate forest product shortages is, at best, a long range solution.

Use of fertilization, genetically improved stock, and more efficient cultural measures would help improve timber growth.

To suggest that substitutes for wood be used to solve the timber supply problems might not be desirable. Most involve more serious environmental impact than results from wood production and use. Substitutes will be used if timber supplies are not available, but this is likely to be at higher costs.

Finally, a very practical alternative is to improve the supply of timber in this country by a general intensification of forest management. In this way, most timber shortages could

be minimized or avoided. This Nation as well as this Basin can at least double the level of timber growth, in time, if sufficient funds can be invested for such purposes as planting, thinning, and protection.

Environmental Quality

Visual landscape quality constraints were developed1/ and used to determine the percentages of major uses which contribute pattern to the land form, thus enhancing the visual quality of the landscape. The result was the percentages of water surface, open space (cropland and pasture) and forest land which should be maintained to enhance the visual quality.

The recommendations for ideal patterns of visual land uses were then entered as constraints in a linear programming model. The differences between the efficiency runs and the environmental quality runs was utilized to estimate the cost of visual quality. Quantitative measures are obtained by examining differences in total and in land use distribution.

For those Land Resource Areas (LRA's) (Figure 5, page S-11) occurring in the James River Basin, it was determined that LRA's 128 and 148 needed more water area, LRA 136 needed more open space and more water area and LRA's 149, 153, and 133 had approximately ideal mixes of open space, forest and water areas.

Since recommended patterns of visual land use were made on the basis of current normal (existing 1964) land use, the acreages of crops in the visual quality solution should not differ significantly from the acreages existing in 1964 for those types of land use where no change was recommended. The increased cost of production per acre between the 1980 efficiency solution and the visual quality solution is viewed as the per acre cost of imposing visual quality constraints on patterns of land use.

Constraints were entered into the linear programming model simulating the recommendations outlined previously for each LRA. Results for the three major types of visual land use are presented in Table VII-6. Subregions 211 and 212 added the required water areas. Subregion 213 added more open space and more water area. Subregion 214 had an approximatley ideal visual pattern of land in 1964 and maintained it in the visual quality solution.

1/ "North Atlantic Regional Water Resources Study, Study of Visual and Cultural Environment, Visual Landscape Quality Constraints" prepared by Research Planning and Design Associates, Inc., Amherst, Mass., for the North Atlantic Regional Water Resources Study Coordinating Committee, November 1968.

Table VII-6. Visual pattern of land use, James River Basin

	Current Normal - 1964	Efficiency 1980	Visual Quality
	Acres		
Subregion 211			
Open Space	336,477	548,712	277,691
Forest	1,411,659	340,729	944,558
Water	7,623	7,623	58,149
Subregion 212			
Open Space	399,757	634,664	335,487
Forest	1,232,282	217,685	1,006,425
Water	26,265	26,265	27,573
Subregion 213			
Open Space	312,170	333,709	382,408
Forest	1,261,089	337,471	1,084,487
Water	24,511	24,511	79,532
Subregion 214			
Open Space	354,659	299,113	337,201
Forest	652,489	163,861	526,453
Water	123,121	123,121	123,121
James River Basin			
Open Space	1,405,063	1,816,198	1,322,787
Forest	4,557,519	1,059,746	3,561,923
Water	181,520	181,520	288,375

The 1980 efficiency solution contained more acres of open space than the visual quality solution in subregions 211 and 212 and less acres in subregions 213 and 214. The entire Basin showed more acres of open space in the 1980 efficiency run. Forest land was greater in the visual quality solution for every subregion and thus for the entire Basin.

The increased cost per acre of meeting the visual quality constraints when compared to the 1980 efficiency solution are shown in Table VII-7. The cost increase per acre is the amount associated with meeting food and fiber demands in the North Atlantic Region while simulataneously maintaining desirable visual patterns of land use.

Table VII-7. Cost per acre, visual quality versus 1980 efficiency solution, James River Basin, Virginia

LRA	1980 Efficiency Solution	Visual Quality Solution	Cost Increase Per Acre 1/
		Dollars	
128	5.56	11.55	5.99
133	5.65	16.66	11.01
136	3.51	19.46	15.95
148	10.29	18.73	8.44
149	6.50	17.16	10.66
153	6.71	17.22	10.51

1/ Price base 1965.

Visual landscape quality is not the only environmental quality consideration which we need to be concerned with. Other environmental considerations include water, air and noise pollution as well as less direct things such as the quality of life, the quality of the recreation experience, etc. The program discussed in this report can affect such environmental considerations as water pollution, the quality of life and of the recreation experience, and other similar considerations. The USDA program can do little, however, to solve environmental problems resulting from air and noise pollution and other similar problems.

Fish and Wildlife

Structure sites and water yields are more than adequate throughout the Basin to meet the projected overall demands of 160,000 acres for new fishing waters in 2020. Stream and salt water fishing opportunities may be increased slightly by providing more convenient access to underfished areas.

The greatest potential for increasing the surface waters available to the public is to include fishing as an added purpose in water supply, flood control, and other such impoundments. Table VII-2 shows that maximum potential development of all reservoir sites studied for upstream watershed projects could provide 145,490 acres of new water surface. These impoundments could be developed for multipurpose use to include fishing or for single purpose recreation use.

Another estimated 30,000 acres could be added in approximately 10,000 farm ponds. The primary purpose served by many of the ponds will be for livestock water or irrigation with fishing recreation as an incidental use. However, an increasing number are being developed to provide the maximum fishing potential and are being managed to supplement farm income from the sale of fishing privileges. Other small

fishing lakes are being planned as the primary attraction of income-producing recreation facilities which may include campgrounds or vacation cottages.

Economic, rather than physical, factors limit the potential for development of reservoirs on the main stem and major tributaries. Costs of relocating railroads, industry, and urban centers would be exorbitant in many sites. However, already under construction or being planned to include a total of approximately 10,000 acres are several large reservoirs, such as the Corps of Engineers Gathright project and the Virginia Electric and Power Company hydro-electric facility on Back Creek. Similar projects have a probable development potential to provide another 60,000 acres of new waters for fishing recreation.

Trout fishing in the Ridges and Valleys and the Blue Ridge attracts thousands of sportsmen during the season following the stocking of hatchery trout in the carefully selected streams which will support this put-and-take fishing. The Virginia Commission of Game and Inland Fisheries indicates that expansion of trout fishing is only possible by increasing the frequency of hatchery trout releases and the total numbers released.

Several factors have combined to cause a leveling off or slight decline in participation rates for hunting during the past decade. There are ample resources in the way of wildlife populations and land suitable for production and harvest of wildlife to reverse that trend. The major opportunity lies in privately-owned, land which supplies 80 to 90 percent of the game harvest. If landowners are provided with adequate incentive to manage their lands for production and harvest of game animals, an upward trend in hunting could be expected. Other opportunities are in provisions for hunter access and assurance of adequate mitigation of habitat losses in project development areas.

Water Quality Control

Water quality control needs in upstream watersheds primarily involve mitigation of damage to fish habitat resulting from installation of impoundments and channel improvement measures. The development potential for storage for low flow augmentation is more than adequate for these needs. Storage and cold water releases can be incorporated in the proposed reservoirs. Careful planning of channel improvements with full consideration for preservation of natural habitat and installation of measures to simulate the natural habitiat could help offset any real damage to these fisheries.

Where pollutants such as industrial waste or sewage become a problem, the local situation will indicate which measures afford the best solution. Only by study of the specific situation can it be determined if development of the water resource affords the most feasible remedy.

Potential Recreation Supply

The inventory of potential recreation supply was tabulated to reflect programmed recreation resource development prior to 1980 for Federal, State, and local agencies within the Basin (Table VII-8). This inventory as presented does not include unprogrammed recreation supply attributable to the expansion of public and private developments for target years nor recreation supply that would occur incidental to the existing programmed supply on undeveloped lakes and streams.

Table VII-8. Annual outdoor recreation day capacity or programmed recreation supply by subarea and water dependency level 1/, James River Basin

Subarea	Acres	Annual Recreation Day Capacity (1000)			
		WD 2/	WE 3/	NW 4/	Total
Appalachia	10,210	216	127	-	390
Appomattox	107	-	10	18	28
Richmond	1,420	113	610	90	813
Norfolk	2,033	-	47	-	47
James River Basin	13,770	329	1,027	108	1,464

1/ Includes public supply only.

2/ Water dependent recreation activities.

3/ Water enhanced recreation activities.

4/ Recreation activities not dependent or enhanced by water.

Table VII-8 shows that programmed recreation development, if funded, would add approximately 1.5 million annual recreation days to the existing recreation capacity of the James River Basin. This increase can be related primarily to the expansion of water enhanced recreation activities, the majority of which would take place in the Richmond subarea. Increased recreation supply in the Appalachia and Appomattox subareas is mostly attributable to additional land acreage and related facility developments that would occur under the present land acquisition and recreation development program of the U.S. Forest Service.

It is clear that in trying to achieve a balance between recreation supply and need, existing recreation resources will have to be modified and expanded where possible. This is particularly true of the urban areas where population increases are felt most and where the natural resource base is at least able to satisfy demand. Here the pressure to consign more land to industry, housing, highways, etc., has oftentimes effectively destroyed or deteriorated beyond repair biotic communities and their related environment whose mere presence and diverse character would otherwise enrich the meaning and enjoyment of human life.

It is imperative that any proposed recreation development take into account resource capability as well as needs satisfaction. This must be done lest people, by their behavior and numbers, destroy the very values they are seeking. It is imperative also that a diversity of recreation opportunity be made available to the public insofar as possible by utilizing the existing natural resource base without causing environmental change or development that would tend to degrade the significant natural, scientific, or recreation character of such resources.

An integral part of the Basin plan for a quality environment is water resource development projects proposed by the Corps of Engineers and the Soil Conservation Service. The Soil Conservation Service program is discussed below. The Corps of Engineers program will be discussed in the overall report being written by the Corps.

Soil Conservation Service.

Twenty-six projects in 48 watersheds have been delinea[illegible] which have potential for development under Public Law 566. In Table VII-9 and VII-10 projects having recreation potential are grouped in three categories for tentative priority of development. Early action projects proposed include those meeting the most urgent needs for sediment and flood control plus identified water supply and recreation within the project area. PL-566 impoundments in general are small and do not have the capacity for satisfying recreation demand for power boating or water skiing. They do, however,

provide an opportunity for meeting small boating demands and other recreation activities normally associated with water. Structures which have included recreation as a project purpose were evaluated assuming optimum project storage. Any reduction in storage would result in a corresponding loss in estimated annual visitation. As shown in Table VII-9 the early implementation of selected projects would provide an estimated 420,100 annual recreation days, most of which are in the Appalachia and Appomattox subareas.

Table VII-9. Potential PL-566 projects including outdoor recreation as a project purpose, James River Basin

Subarea	Stream Name and CNI Watershed Nos.	Structure No. ()	Acreage Land	Acreage Water	Estimated Annual Recreation Days 1/ Initial	Estimated Annual Recreation Days 1/ Ultimate
Early Action						
1	Upper Jackson River 12-6,7	12-6 (1G)	390	489	78,000	117,600
1	Cowpasture River 12-12,13,14	12-12 (1B) 2/	420	526	84,000	210,400
1	Calfpasture River 12a-1	12a-1 (6)	53	53	21,200	21,200
2	Tye River 12-25	12-25 (4)	50	62	24,800	24,800
2	Piney River 12-26	12-26 (3)	110	143	57,200	57,200
2	Hardware River 12-30	12-30 (2A)	200	134	80,000	80,000
3	North Fk. Rivanna River 12-6,1,2,7,12	12-12 (11)	332	416	74,900	166,400
Intermediate Action						
1	Potts Creek 12-9,10,11	12-10 (6)	40	50	20,000	20,000
		12-11 (1A)	125	254	76,200	76,200
1	Catawba Creek 12-22	12-22 (7)	100	127	50,000	50,000
2	Rockfish Creek 12-23,24	12-23 (2)	120	185	77,200	77,200
		12-23 (3)	130	146	58,400	58,400
		12-24 (1)	130	159	63,600	63,600
3	Beaver Dam Creek 12-50	12-50 (1A)	246	246	123,000	123,000
3	South Fk. Rivanna River 12-3,4,5,6,13,14	12b-4 (1B)	292	438	75,000	175,200
		12b-6 (4B)	146	182	72,800	72,800
3	Upper Appomattox River 12c-1,2,12	12c-1 (4A)	466	680	75,000	280,000
3	Middle Appomattox River 12c-3,4	12c-3 (11B)	700	1,049	75,000	419,600
		12c-4 (1C)	667	1,000	75,000	400,000
		12c-4 (5B)	1,038	734	75,000	440,000
Long Range						
2	Bent Creek 12-41	12-41 (1A)	177	274	42,400	106,000
2	Wreck Island Creek 12-42	12-42 (3)	234	350	56,000	140,000
3	Byrd Creek 12-44	12-44 (3)	234	352	56,000	140,000
3	Flat Creek 12c-6,9,13,14	12c-6 (1B)	775	1,082	75,000	500,000
		12c-9 (1B)	830	1,246	75,000	500,000
	Total		8,005	10,377	1,641,120	4,319,600

Source: 1972 Preliminary BOR report for the James River Basin, Virginia.

1/ Annual recreation days based on optimum project storage.

2/ Project is in conflict with Bullpasture River proposed for inclusion into the Virginia Scenic River System. Other impoundments in conflict include structure 12-12(1B) on Cowpasture River.

Table VII-10. Summary. Potential PL-566 projects including outdoor recreation as a project purpose, James River Basin

Subarea	Time Frame	No. of Res.	Acreage			Annual Recreation Days (1000's)		
			Land	Water	Total	1980	1980-2000	2000-2020
1	Early Action	3	863	1,068	1,931	183.2	266.2	349.2
	Inter. Action	3	265	431	696		146.2	146.2
2	Early Action	3	360	339	699	162.0	162.0	162.0
	Inter. Action	3	380	490	870		199.2	199.2
	Long Range	2	411	624	1,035			98.4
3	Early Action	1	332	416	748	74.9	120.6	166.4
	Inter. Action	7	3,555	4,329	7,884		570.8	1,910.6
	Long Range	3	1,839	2,680	4,519			206.0
	Total	25	8,005	10,377	18,382	420.1	1,465.0	3,238.0

Source: Soil Conservation Service, USDA.

CHAPTER VIII

OPPORTUNITIES FOR DEVELOPMENT UNDER USDA AND RELATED PROGRAMS

The potential for meeting the needs of the Basin as described in Chapter VII are translated into workable opportunities and programs in this chapter. Opportunities for development are not specifically limited to USDA programs but certainly discussion will concentrate on these programs. A specific program for development is not proposed but rather a discussion of alternatives for meeting needs. Federal and local planners must exercise judgment when defining and initiating a program of action for the community.

Public Law 566 Projects

Twenty-six projects comprising 48 watersheds delineated for the Conservation Needs Inventory (CNI) afford opportunities for development under Public Law 566 (PL-566). The projects were grouped in three categories for tentative priority of development. Early action projects includes those meeting the most urgent needs and offering the best chance of development in the next 10 to 15 years. Intermediate range projects include those listed for development from 1980 to 2000. Long range projects include those which would be deferred until the 2000 to 2020 period.

Figure 13 shows the location and indicates the priority category of each project. Table VIII-1 shows a summary of amounts and cost allocation of land treatment. Tables VIII-2 and VIII-3 show summaries of structural and cost data and other pertinent information on the 26 projects.

Total installation cost for structural measures of the indicated levels of development are estimated to be $110,618,600. Of this total, other costs, which approximate cost to local interest, are estimated to be $33,469,100. PL-566 costs are estimated to be $76,149,500.

Early Action Projects

Twelve PL-566 projects comprising 19 CNI watersheds afford opportunities for development by 1980 (Figure 13). Table VIII-4 shows the amounts and cost allocation of land treatment for each project and totals. Tables VIII-5 and VIII-6 show structural and cost data developed using discount rates of 5-5/8 percent and other pertinent data on the 12 projects.

Tye River, Piney River and Hardware River watersheds were devastated by the flood of August 1969. Permanent measures are urgently

Table VIII-1. Summary of estimated acreage and land treatment cost, PL-566 Projects, James River Basin 4/

Priority Category	Crop-land	Pasture-land	Forest-land	Critical Areas 3/	Total	Cost (Dollars) 5/		
						P.L.566 1/	Other 2/	Total
	Acres							
Early Action	29,330	77,900	79,960	2,740	189,930	914,700	4,080,400	4,995,100
Intermediate Action	38,440	49,770	100,030	2,060	190,300	697,400	3,185,300	3,882,700
Long Range	23,640	10,130	61,200	1,130	96,100	415,200	1,321,600	1,736,800
Total	91,410	137,800	241,190	5,930	467,330	2,027,300	8,587,300	10,614,600

1/ Cost for accelerated land treatment.

2/ Cost to landowners, PL-46 and related programs.

3/ Areas of severe sheet or gully erosion.

4/ Same as Table S-3.

5/ Base year 1967.

Table VIII-2. Structural summary data, PL-566 Projects, James River Basin3/

Priority Category	W/S-D.A 1/	Structural Sites	D.A. Above Sites	Structural Data: Allocated Storage 2/: Sediment	Flood	Supply	Rec.	Total	Normal Pool	Channel Improv.	Unallocated Storage
	Sq.Mi.		Sq. Mi.		Acre	Feet			Acres	Miles	Ac.-Ft.
Early Action	1798.1	57	678.0	25,375	144,755	16,785	48,785	235,220	3,835	42.2	296,125
Intermediate Action	1696.8	45	885.3	40,290	205,205	20,870	85,930	325,295	7,811	98.1	323,365
Long Range Action	813.1	17	303.9	16,205	58,485	4,000	48,170	126,860	4,315	101.3	109,905
Total	4208.0	119	1,867.2	81,870	408,445	41,175	182,885	714,375	15,961	241.6	729,395

1/ Watershed Drainage Area

2/ Suggested level of development to meet identified needs.

3/ Same as Table S-4.

Table VIII-3. Summary cost data, PL-566 Projects, James River Basin 3/

Priority Category	Installation Cost 1/						
	Flood Prevention	Water Supply	Recreation	Total Installation	Average Annual Installation	Average Annual O&M	Total Average Annual
	Thousands of Dollars						
Early Action	30,111.0	3,065.6	7,909.1	41,085.7	2320.9	329.0	2649.9
Intermediate Action	31,211.7	2,508.9	15,078.8	48,799.4	2756.6	833.8	3590.4
Long Range	12,773.8	408.0	7,551.7	20,733.5	1171.3	410.1	1581.4
Total	74,096.5	5,982.5	30,539.6	110,618.6	6,248.8	1572.9	7,821.7

1/ At suggested level of development to meet identified needs.

2/ Amortized for 1967 dollars, 5-5/8 percent interest rate and 100-year economic life.

3/ Same as Table S-5.

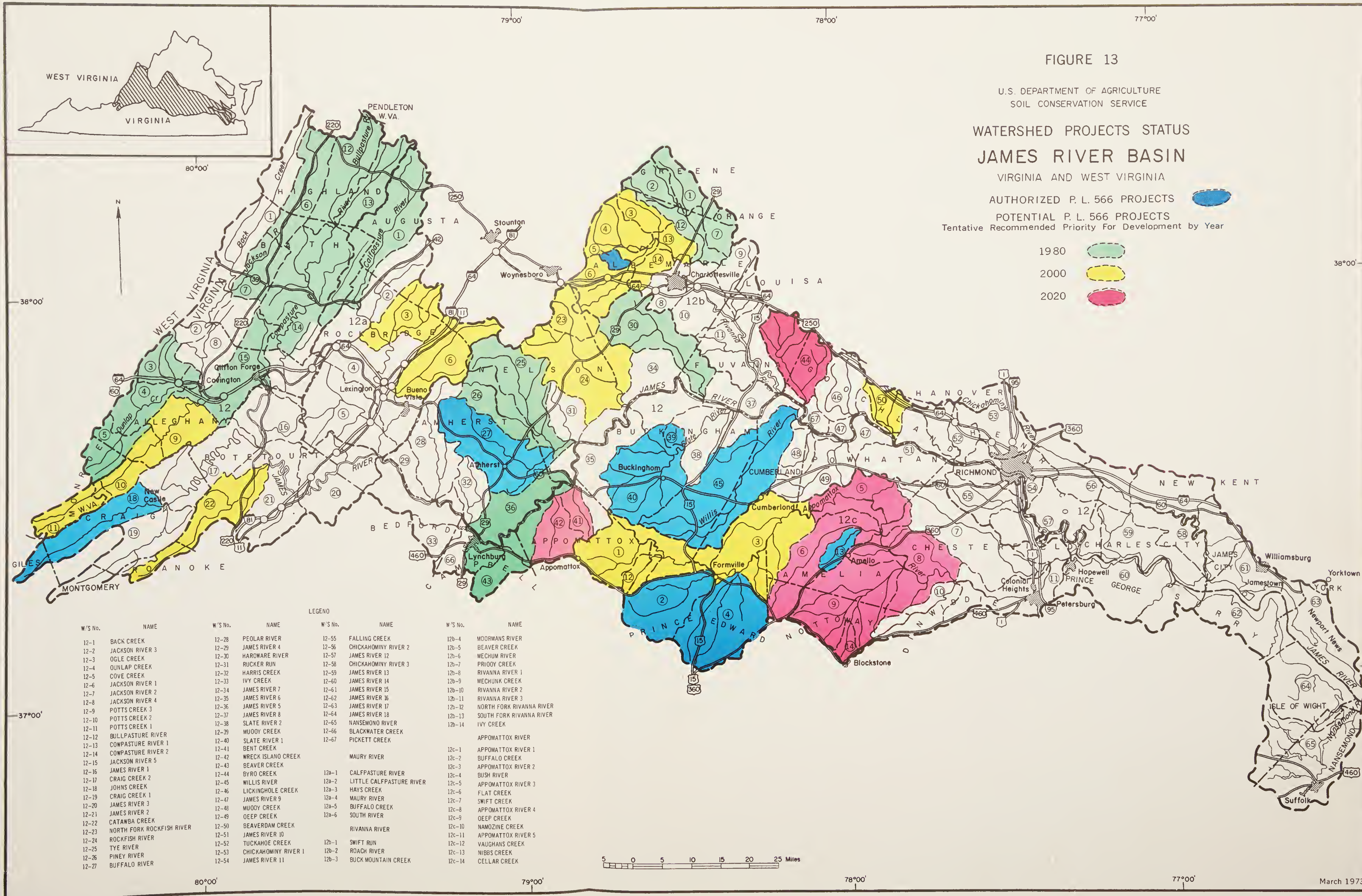

FIGURE 13

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WATERSHED PROJECTS STATUS

JAMES RIVER BASIN

VIRGINIA AND WEST VIRGINIA

AUTHORIZED P. L. 566 PROJECTS

POTENTIAL P. L. 566 PROJECTS
Tentative Recommended Priority For Development by Year

1980
2000
2020

LEGENO

W/S No.	NAME
12-1	BACK CREEK
12-2	JACKSON RIVER 3
12-3	OGLE CREEK
12-4	OUNLAP CREEK
12-5	COVE CREEK
12-6	JACKSON RIVER 1
12-7	JACKSON RIVER 2
12-8	JACKSON RIVER 4
12-9	POTTS CREEK 3
12-10	POTTS CREEK 2
12-11	POTTS CREEK 1
12-12	BULLPASTURE RIVER
12-13	COWPASTURE RIVER 1
12-14	COWPASTURE RIVER 2
12-15	JACKSON RIVER 5
12-16	JAMES RIVER 1
12-17	CRAIG CREEK 2
12-18	JOHNS CREEK
12-19	CRAIG CREEK 1
12-20	JAMES RIVER 3
12-21	JAMES RIVER 2
12-22	CATAWBA CREEK
12-23	NORTH FORK ROCKFISH RIVER
12-24	ROCKFISH RIVER
12-25	TYE RIVER
12-26	PINEY RIVER
12-27	BUFFALO RIVER
12-28	PEOLAR RIVER
12-29	JAMES RIVER 4
12-30	HAROWARE RIVER
12-31	RUCKER RUN
12-32	HARRIS CREEK
12-33	IVY CREEK
12-34	JAMES RIVER 7
12-35	JAMES RIVER 6
12-36	JAMES RIVER 5
12-37	JAMES RIVER 8
12-38	SLATE RIVER 2
12-39	MUOOY CREEK
12-40	SLATE RIVER 1
12-41	BENT CREEK
12-42	WRECK ISLANO CREEK
12-43	BEAVER CREEK
12-44	BYRO CREEK
12-45	WILLIS RIVER
12-46	LICKINGHOLE CREEK
12-47	JAMES RIVER 9
12-48	MUOOY CREEK
12-49	OEEP CREEK
12-50	BEAVERDAM CREEK
12-51	JAMES RIVER 10
12-52	TUCKAHOE CREEK
12-53	CHICKAHOMINY RIVER 1
12-54	JAMES RIVER 11
12-55	FALLING CREEK
12-56	CHICKAHOMINY RIVER 2
12-57	JAMES RIVER 12
12-58	CHICKAHOMINY RIVER 3
12-59	JAMES RIVER 13
12-60	JAMES RIVER 14
12-61	JAMES RIVER 15
12-62	JAMES RIVER 16
12-63	JAMES RIVER 17
12-64	JAMES RIVER 18
12-65	NANSEMONO RIVER
12-66	BLACKWATER CREEK
12-67	PICKETT CREEK
	MAURY RIVER
12a-1	CALFPASTURE RIVER
12a-2	LITTLE CALFPASTURE RIVER
12a-3	HAYS CREEK
12a-4	MAURY RIVER
12a-5	BUFFALO CREEK
12a-6	SOUTH RIVER
	RIVANNA RIVER
12b-1	SWIFT RUN
12b-2	ROACH RIVER
12b-3	BUCK MOUNTAIN CREEK
12b-4	MOORMANS RIVER
12b-5	BEAVER CREEK
12b-6	MECHUM RIVER
12b-7	PRIOOY CREEK
12b-8	RIVANNA RIVER 1
12b-9	MECHUNK CREEK
12b-10	RIVANNA RIVER 2
12b-11	RIVANNA RIVER 3
12b-12	NORTH FORK RIVANNA RIVER
12b-13	SOUTH FORK RIVANNA RIVER
12b-14	IVY CREEK
	APPOMATTOX RIVER
12c-1	APPOMATTOX RIVER 1
12c-2	BUFFALO CREEK
12c-3	APPOMATTOX RIVER 2
12c-4	BUSH RIVER
12c-5	APPOMATTOX RIVER 3
12c-6	FLAT CREEK
12c-7	SWIFT CREEK
12c-8	APPOMATTOX RIVER 4
12c-9	OEEP CREEK
12c-10	NAMOZINE CREEK
12c-11	APPOMATTOX RIVER 5
12c-12	VAUGHANS CREEK
12c-13	NIBBS CREEK
12c-14	CELLAR CREEK

Table VIII-4. Estimated acreage and land treatment cost, Early Action Projects, James River Basin

Watershed	Cropland	Pastureland	Forest land	Critical Area 3/	Total	Cost 4/ PL-566 1/	Cost 4/ Other 2/	Cost 4/ Total
	Acres					Dollars		
Ogle Creek	320	1,270	1,690	60	3,390	17,200	72,000	89,200
Dunlap Creek	860	3,360	4,490	190	8,900	50,100	198,100	248,200
Upper Jackson	1,540	8,330	4,690	240	14,800	72,800	374,900	447,700
Cowpasture River	4,580	24,710	13,910	660	43,860	263,400	1,044,700	1,308,100
Jackson River 5	810	3,160	4,690	150	8,810	44,500	230,000	274,500
Tye River	2,120	3,100	10,360	180	15,760	68,000	252,300	320,300
Piney River	1,470	1,870	5,120	110	8,570	38,000	142,400	180,400
Hardware River	2,400	6,340	8,340	180	17,260	71,600	338,400	410,000
James River 5	4,480	2,940	10,540	470	18,430	85,100	356,700	441,800
Beaver Creek	1,100	720	2,580	60	4,460	20,200	68,600	88,800
Calfpasture River	6,560	13,960	2,840	220	23,580	93,600	570,300	663,900
North Fork Rivanna River	3,090	8,140	10,710	220	22,160	90,200	432,000	522,200
Total	29,330	77,900	79,960	2,740	189,930	914,700	4,080,400	4,995,100

1/ Cost for accelerated land treatment.

2/ Cost to landowners, PL-46 and related programs.

3/ Areas of severe sheet or gully erosion.

4/ Base year 1967.

Table VIII-5. Structural summary data, PL-566 Projects, Early Action, James River Basin

Watershed	Structural Data								Normal Pool	Channel Improv.	Unallocated Storage
	W/S-D.A. 1/	Structural Sites	D.A. Above Sites	Allocated Storage: Sediment	Flood	Water Supply	Rec.	Total			
	Sq. Mi.		Sq. Mi.	Acre-Feet					Acres	Miles	Ac. Ft.
Ogle Creek 12-3	45.8	5	25.1	810	4,575	1,000	-	6,385	61	-	13,230
Dunlap Creek 12-4,5	121.8	7	44.7	1,430	8,095	3,150	-	12,675	136	-	22,105
Upper Jackson River 12-6,7	156.5	4	63.2	2,030	11,745	1,000	15,835	30,610	585	7.9	16,955
Cowpasture River 12-12,13,14	464.3	6	184.3	5,900	29,820	1,000	14,195	50,915	772	1.9	84,080
Jackson River 5 12-15	114.4	3	37.3	1,195	6,920	3,000	-	11,115	137	-	16,920
Tye River 12-25	134.9	4	56.2	1,800	15,120	500	500	17,920	135	10.9	28,985
Piney River 12-26	70.4	3	34.3	1,095	9,380	500	3,865	14,840	197	-	10,530
Hardware River 12-30	138.0	6	44.2	2,350	12,210	1,060	3,935	19,555	472	8.4	18,545
James River 5 12-36	151.3	2	11.0	585	2,475	500	-	3,560	54	11.6	5,350
Beaver Creek 12-43	37.0	2	9.3	495	2,090	500	-	3,085	65	1.5	4,450
Calfpasture River 12a-1	186.4	8	61.1	1,955	11,140	1,500	205	14,800	272	-	30,895
No. Fork Rivanna R. 12b-1,2,7,12	177.3	7	107.3	5,730	31,185	2,595	10,250	49,760	949	-	44,080
Subtotal	1,798.1	57	678.0	25,375	144,755	16,305	48,785	235,220	3,835	42.2	296,125

1/ Watershed Drainage Area

Table VIII-6. Summary cost data, PL-566 Projects, Early Action, James River Basin

Watershed	Installation Cost 1/						
	Flood Prevention	Water Supply	Recreation	Total Installation	Average Annual Installation	Average Annual O&M 3/	Total Average Annual 2/
	Thousands of Dollars						
Ogle Creek 12-3	1,663.3	324.4	-	1,987.7	112.3	1.5	113.8
Dunlap Creek 12-4,5	2,046.7	333.8	-	2,379.5	134.4	3.5	137.9
Upper Jackson 12-6,7	2,228.1	254.5	1,900.3	4,382.9	247.6	71.2	318.8
Cowpasture River 12-12,13,14	5,932.9	157.7	2,530.3	8,620.9	487.0	75.5	526.5
Jackson River 5 12-15	2,314.7	743.2	-	3,057.9	172.7	4.0	176.7
Tye River 12-25	3,808.2	106.9	193.8	4,108.9	232.1	12.9	245.0
Piney River 12-26	2,592.8	169.2	811.7	3,573.7	201.9	26.7	228.6
Hardware River 12-30	1,696.8	115.4	965.6	2,777.8	156.9	51.8	208.7
James River 5 12-36	593.1	104.5	-	697.6	39.5	2.0	41.4
Beaver Creek 12-43	531.5	81.7	-	613.2	34.6	1.5	36.1
Calfpasture River 12a-1	3,930.0	444.1	238.4	4,612.5	260.6	15.1	275.7
No. Fork Rivanna 12b-1,2,7,12	2,772.9	231.2	1,269.0	4,273.1	241.4	63.3	304.7
Subtotal	30,111.0	3,065.6	7,909.1	41,085.7	2,320.9	329.0	2,649.9

1/ No cost included for unallocated storage.
2/ 5-5/8 percent interest rate for 100 years.
3/ Includes cost of replacement features.

needed to reinforce and prolong the effectiveness of emergency measures now being installed.

Beaver Creek, James River 5, and North Fork Rivanna River projects were selected for early action primarily because of a high level of local interest - also willingness and institutional capability to carry out local responsibilities were rated above-average in these projects.

The other six projects are wholly or partly in the Appalachia Regional Development Area which includes the counties of Alleghany, Bath, Highland, Botetourt, and Craig. Urgent priorities have been assigned under the Appalachia program to meet special economic and social problems and needs of the area. PL-566 projects afford opportunities to help meet the objectives of the Appalachia program. Early attention will be directed toward coordination of PL-566 developments with other efforts in the area.

At the indicated levels of development, total costs for installation of structural measures are estimated to be $41,085,700 (Table VIII-6). The 57 impoundments proposed for development could provide an additional 296,125 acre-feet of storage for recreation, water supply, or other purposes.

Intermediate Range Projects

Nine projects are tentatively recommended for development in the 1980 to 2000 period. Table VIII-7 shows the amounts and cost allocation for land treatment. Tables VIII-8 and VIII-9 show structural and cost data and other pertinent information on the nine projects.

As shown on Figure 13, seven of the projects are in the Ridges and Valleys, Blue Ridge or upper Piedmont. The other two projects include the upper portion of the Appomattox River drainage. Generally, needs are less urgent or present capabilities for meeting local responsibilities are rated lower in these projects than in the early action projects.

Total installation costs of structures at indicated levels of development are estimated to be $48,799,400. The 45 impoundments proposed for development could provide an additional 323,365 acre-feet of storage to meet needs for recreation, water supply, or other purposes.

Long Range Projects

Five projects are tentatively recommended for development in the 2000 to 2020 period. Table VIII-10 shows the amounts and cost

Table VIII-7. Estimated acreage and land treatment cost, Intermediate Action Program, James River Basin

Watershed	Cropland	Pastureland	Forestland	Critical Area[3]	Total	Cost[4] PL-566[1]	Cost[4] Other[2]	Cost[4] Total
	Acres					Dollars		
Potts Creek	1,220	4,780	7,100	180	13,280	60,000	267,300	327,300
Catawba Creek	2,770	4,120	3,250	110	10,250	42,600	206,400	249,000
Rockfish River	3,870	7,700	18,990	110	30,670	99,000	440,300	539,300
Beaverdam Creek	1,460	990	2,590	80	5,120	25,300	85,400	110,700
Hays Creek	1,620	4,910	2,560	100	9,190	37,900	214,100	252,000
South River	2,010	6,090	3,180	160	11,440	49,500	273,400	322,900
South Fork Rivanna River	4,650	12,260	16,120	340	33,370	136,800	652,000	788,800
Upper Appomattox River	11,080	5,360	21,110	580	38,130	182,100	579,000	761,100
Middle Appomattox	9,760	3,560	25,130	400	38,850	64,200	467,400	531,600
Total	38,440	49,770	100,030	2,060	190,300	697,400	3,185,300	3,882,700

1/ Cost for accelerated land treatment
2/ Cost to landowners, PL-46 and related programs
3/ Areas subject to severe sheet and gully erosion
4/ Base year 1967

Table VIII-8. Structural summary data, PL-566 Projects, Intermediate Action, James River Basin

Watershed	Structural Data								Normal Pool	Channel Improv.	Unallocated Storage
	W/S-D.A. 1/	Structural Sites	D.A. Above Sites	Allocated Storage: Sediment	Flood	Water Supply	Rec.	Total			
	Sq. Mi.		Sq. Mi.	Acre-Feet					Acres	Miles	Ac.Ft.-
Potts Creek 12-9,10,11	173.3	3	90.4	2,895	16,385	1,500	5,265	26,045	445	-	29,950
Catawba Creek 12-22	115.3	6	60.4	1,935	14,295	11,520	2,815	30,565	572	10.2	17,835
Rockfish River 12-23,24	247.3	6	73.3	2,345	20,790	615	9,350	33,100	635	7.8	29,110
Beaverdam Creek 12-50	40.1	2	27.1	1,445	5,355	1,000	1,750	9,550	410	5.4	11,710
Hays Creek 12a-3	95.8	2	44.9	1,440	10,980	500	-	12,920	107	9.7	23,460
South River 12a-6	118.8	8	58.5	1,935	17,770	2,920	-	22,625	294	-	28,215
South Fork Rivanna 12b-3,4,5,6,13,14	266.8	7	191.0	10,190	54,435	2,090	10,180	76,895	1,055	-	89,600
Upper Appomattox River, 12c-1,2,12	303.2	3	128.8	6,870	24,945	725	13,565	46,105	6,725	19.3	24,060
Middle Appomattox River, 12c-3,4	336.2	8	210.9	11,235	40,250	-	43,005	94,490	3,359	45.7	94,490
Subtotal	1,696.8	45	885.3	40,290	205,205	20,870	85,930	352,295	7,811	98.1	323,365

1/ Watershed Drainage Area

Table VIII-9. Summary cost data, PL-566 Projects, Intermediate Action, James River Basin

Watershed	Installation Cost 1/						
	Flood Prevention	Water Supply	Recreation	Total Installation	Average Annual Installation	Average Annual O&M	Total Average Annual 2/
	Thousands of Dollars						
Potts Creek 12-9,10-11	3,171.9	290.0	1,426.2	4,888.1	276.1	44.6	320.7
Catawba Creek 12-22	3,036.2	1,327.4	540.1	4,903.7	277.0	25.3	302.3
Rockfish River 12-23,24	3,307.0	81.5	2,057.6	5,176.1	292.4	90.5	382.9
Beaverdam Creek 12-50	929.9	135.4	823.9	1,889.2	106.7	55.1	161.8
Hays Creek 12a-3	1,882.9	50.3	-	1,933.2	109.2	1.0	110.2
South River 12a-6	4,301.7	426.7	-	4,728.4	267.1	5.0	272.1
South Fork Rivanna 12b-3,4,5,6,13,14	5,104.5	148.0	1,910.9	7,163.4	404.7	98.5	503.2
Upper Appomattox 12c-1,2,12	2,652.0	49.6	1,692.1	4,393.7	248.2	95.5	343.7
Middle Appomattox 12c-3,4	7,095.6	-	6,628.0	13,723.6	775.2	418.3	1,193.5
Subtotal	31,211.7	2,508.9	15,078.8	48,799.4	2,756.6	833.8	3,590.4

1/ No cost included for unallocated storage. Base year 1967.

2/ 5-5/8 percent interest rate for 100 years

Table VIII-10. Estimated acreage and land treatment cost, Long Range Project, James River Basin

Watershed	Cropland	Pastureland	Forestland	Critical Area 3/	Total	Cost 4/ PL-566 1/	Cost 4/ Other 2/	Cost 4/ Total
	Acres					Dollars		
Bent Creek	760	500	2,380	40	3,680	15,400	52,600	68,000
Wreck Island Creek	1,420	930	4,480	80	6,910	29,700	99,800	129,500
Byrd Creek	2,450	2,280	9,000	160	13,890	59,600	210,700	270,300
Lower Appomattox	7,850	2,650	18,720	360	29,580	129,500	397,900	527,400
Deep Creek - Flat Creek	11,160	3,770	26,620	490	42,040	181,000	560,600	741,600
Total	23,640	10,130	61,200	1,130	96,100	415,200	1,321,600	1,736,800

1/ Cost for accelerated land treatment.

2/ Cost to landowners, PL-46 and related programs.

3/ Areas subject to severe sheet and gully erosion.

4/ Base year 1967.

allocation for land treatment. Tables VIII-11 and VIII-12 show structural and cost data and other pertinent information on the five projects.

As shown in Figure 13, these projects are located in the middle and lower Piedmont. The Coastal Plain does not appear to afford any potential for development under PL-566.

The deferred priority will allow time for reassessment of these projects. Unanticipated developments may also indicate that other watershed projects should be reexamined. If needs or local interests and capabilities or other considerations change significantly in any upstream watersheds, priorities can be adjusted or other projects included.

Public Law 46 and Related Authorities

Broad objectives of USDA programs are the use of all land according to its capability (Appendix A) and treatment of all land according to its conservation needs. In the next 50 years, about 300,000 acres will be required for new urban, industrial, and highway developments. Forest land acreage will increase by 265,000 acres. Net reductions of about 500,000 acres in cropland and 300,000 acres in pasture are projected.

These conversions represent new opportunities for adapting use and treatment to land capability. Special efforts should be directed to encourage shifts of cropland from land in capability classes VIe and VIIe to more suitable soils.

Conservation treatment is inadequate on 468,200 acres of cropland, 473,800 acres of pasture, and 1.4 million acres of non-Federal forest land. Changes in use, ownership, and management on 2.7 million acres of "adequately treated" lands generate additional opportunities for planning, application, and maintenance of land treatment measures.

Each year about 6,000 acres are cleared and made extremely vulnerable to erosion in construction areas for new developments. About 15,000 acres of roadside banks and ditches and 11,000 acres of agricultural lands are critical in terms of sediment yields and needs for conservation treatment. A few contractors have made limited application of USDA erosion control techniques and practices on construction areas. PL-566 funds are allocated for materials (seed, fertilizer, lime) labor, equipment and supplementary technical assistance for treatment of critical erosion areas. The Virginia Department of Highways furnishes equipment and labor to use these

Table VIII-11. Structural summary data, PL-566 Projects, Long Range, James River Basin

Watershed	Structural Data								Normal Pool	Channel Improv.	Unallocated Storage
	W/S D.A. 1/	Structural Sites	D.A. Above Sites	Allocated Storage							
				Sediment	Flood	Water Supply	Rec.	Total			
	Sq. Mi.		Sq. Mi.	Acre Feet					Acres	Miles	Ac.Ft.
Bent Creek 12-41	13.0	2	15.2	810	3,390	-	5,485	9,685	284	-	2,590
Wreck Island Creek 12-42	58.3	4	24.7	1,325	5,510	-	6,580	13,415	385	11.9	6,630
Byrd Creek 12-44	117.3	4	32.0	1,710	6,395	-	6,900	15,005	413	13.5	10,200
Lower Appomattox River 12c-5,8	250.4	-	-	-	-	-	-	-	-	37.0	-
Deep Creek - Flat Creek 12c-6,9,13, 14	356.1	7	232.0	12,360	43,199	4,000	29,205	88,755	3,233	38.9	90,485
Subtotal	813.1	17	303.9	16,205	58,485	4,000	48,170	126,860	4,315	101.3	109,905

1/ Watershed Drainage Area

Table VIII-12. Summary cost data, PL-566 Projects, Long Range, James River Basin

Watershed	Installation Cost 1/						
	Flood Prevention	Water Supply	Recreation	Total Installation	Average Annual Installation	Average Annual O&M	Total Average Annual 2/
	Thousands of Dollars						
Bent Creek 12-41	449.6	-	838.4	1,288.0	72.8	38.4	111.2
Wreck Island Creek 12-42	1,194.3	-	901.8	2,096.1	118.4	51.4	169.8
Byrd Creek 12-44	1,094.8	-	989.9	2,084.7	117.8	51.9	169.7
Lower Appomattox 12c-5,8	4,105.5	-	-	4,105.5	231.9	10.0	241.9
Deep Creek - Flat Creek 12c-6,9,13, 14	5,929.6	408.0	4,821.6	11,159.2	630.4	258.4	888.8
Subtotal	12,773.8	408.0	7,551.7	20,733.5	1,171.3	410.1	1,581.4

1/ No cost included for unallocated storage. Base year 1967.

2/ 5-5/8 percent interest rate for 100 years

materials in treatment of roadsides, and landowners furnish labor and equipment for treatment of critical areas on agricultural land in these PL-566 projects. Broad opportunities exist for improvement in treatment of construction areas and in treatment of roadsides and other critical areas outside of PL-566 projects.

Each year an increasing number of requests are received by SCS for soil surveys from planning groups concerned with land use in urban and suburban areas. The field surveys, interpretation of soils data, and related technical assistance mean additional demands for the time and skills of soil scientists. Other personnel are being trained in the broader aspects of land use planning and resource development primarily to assist with the complex problems of urban expansion.

These rapid and sometimes unpredictable changes will require periodic reassessment of specific land treatment needs and will open new avenues for innovation and cooperation in providing services under USDA programs.

National Forest Programs

Timber Management

Management on the National forests provides a never-ending cycle of forest products. Systematically, timber stands are treated by prescribed practices to improve the desirable stems and removal of the undesirable species. Approximately one-third of the National forest land in the study area is too rocky and steep to manage timber for harvesting. The National forests consists of predominantly hardwood tree species. Wildfire, chestnut blight and past harvesting practices have produced many sparse and low quality stands to be regenerated.

Regeneration for the National forest by 2020 will include approximately 272,800 acres or 36 percent of the land area (Tables VIII-13 and VIII-14). These harvested stands will range in size from 10 to 50 acres and will be selected by sites which have potentials for meeting the best management objectives. On regenerated areas several years hence, there will be a need to apply precommercial thinning to approximately 150,000 acres to provide proper growing space for the most desirable species. Intermediate harvestings will need to be applied to approximately 47,300 acres to provide needed growing space and needed forest products. Timber stand improvement will need to be applied to approximately 45,800 acres to favor growth of the best species and selected trees. These practices, ultimately, will produce a greater variety of useful forest products, the sale of which will help bolster the local economy.

Table VIII-13. Land treatment program on George Washington National Forest[1/], James River Basin, Virginia

	Acres		
	1960-1980	1980-2000	2000-2020
Harvest and Regenerate	62,800	70,000	70,000
Pre-commercial Thinning	None	8,400	25,200
Intermediate Cutting	8,200	12,700	12,700
Timber Stand Improvement	25,100[2/]	5,300	82,500

Erosion Control - 1965-1975

Type	Amount	Cost[3/]
Gully Stabilization	173 miles	$ 346,000
Sheet Erosion Control	1,624 acres	243,600
Streambank Stabilization	67 miles	335,000
Abandoned Road and Trail Stabilization	210 miles	42,000
Mined Area Stabilization	25 acres	30,000
Stream Channel Clearing (debris)	640 miles	128,000
	Total	$1,124,600

1/ Comprising 536,200 acres within the James River Basin.

2/ Completed between 1961 and 1968.

3/ Base year, 1970.

Table VIII-14. Land treatment program on Jefferson National Forest[1/], James River Basin, Virginia

	Acres 1960-1980	Acres 1980-2000	Acres 2000-2020
Harvest and Regenerate	20,000	25,000	25,000
Pre-commercial Thinning	6,000	25,000	25,000
Intermediate Cutting	4,000	5,200	5,200
Timber Stand Improvement	10,200[2/]	2,100	3,000

Erosion Control - 1965-1975

Type	Amount	Cost[3/]
Gully Stabilization	22 miles	$ 44,000
Sheet Erosion Control	200 acres	30,000
Streambank Stabilization	20 miles	100,000
Abandoned Road and Trail Stabilization	180 miles	36,000
Mined Area Stabilization	130 acres	200,000
Stream Channel Clearing (debris)	528 miles	105,600
	Total	$515,600

1/ Comprising 218,000 acres within the James River Basin.

2/ Completed between 1961 and 1968.

3/ Base year - 1970.

Watershed Management

Management of watersheds is a very significant use on the George Washington and Jefferson National Forests. Their strategic locations in the upper reaches of the Basin are largely responsible for the high quality of water yielded. Their generally good hydrologic condition adds to the base flow and therefore gives a better time control of the water yields.

Wildlife Management

Wildlife is another major use on the National forests. The Forest Service is cooperating with the Virginia Game and Inland Fisheries to develop an improved wildlife habitat through employment of techniques in forest management. Joint efforts are promoting more and better fishing in both streams and reservoirs. The Forest Service's ultimate goal is to produce the optimum annual crop of game contingent upon land use and development activities.

Recreation Programs

The George Washington and Jefferson National Forests produce large acreages of land or dispersed type of recreation use, as well as developed recreation areas.

Cooperative State and Private Forestry Programs

Timber Management

Management practices as shown on Table VIII-15 are predicated on the basis of meeting the Basin's projected timber supply as shown on Table III-30.

Stand Improvement

There are 1,224,000 acres or 27.8 percent of the forest land recommended for stand improvement which includes stand conversion, regeneration, thinning, and release. These practices will improve the desirable stocking and remove the undesirable stocking. This includes 1,224,300 acres of private land according to Conservation Needs Inventory (CNI) and 158,700 acres of National forest lands. Estimated cost is $3,422,000 for technical assistance and $12,277,000 for installation. Implementation of this practice will meet 93 percent of the total needs. (Table VIII-15).

Table VIII-15. Forest management program 1/, 1960 - 2020, James River Basin

Forest Land Treatment Measures	Total Need	Recommended Program	Percent of Needs Met with Recommended Program	Cost of Recommended Program 2/ Technical Assistance	Installation
	------1,000 acres------			-------1,000 dollars---------	
Private and State Lands					
Stand Improvement 3/	1,497.8	1,224.3	82	$3,029	$10,872
Tree Planting 4/	358.2	358.2	100	2,812	11,323
Watershed Protection 5/	1,961.4	1,961.4	100	280	686
Forest Grazing Protection 6/	104.1	104.1	100	46	433
National Forest Land					
Stand Improvement 3/	502.3	158.7	32	393	1,405
Tree Planting 4/	69.8	69.8	100	704	2,835
Watershed Protection 5/	2,715.6	754.2	28	109	264

1/ Includes private, State, and Federal forest lands.

2/ 1965 dollars.

3/ Includes thinning, thinning and release, stand conversion, regeneration, and other timber management activities which benefit forest hydrologic condition.

4/ Conifers, primarily loblolly, white and Virginia pine.

5/ Includes proper skid trails and logging roads, gully stabilization, sheet erosion control, mined area stabilization, streambank stabilization and stream channel clearing (debris).

6/ Usually includes forest land within fenced pasture where cross-fencing is needed.

Tree Planting

There are 428,000 acres or 9.7 percent of the forest land scheduled for planting to conifers, primarily loblolly, white and Virginia pine. This practice will help offset the rapidly diminishing softwood resource. One-third of this objective has been achieved through current programs. The recommended program includes 358,200 acres of private land according to (CNI) and 69,800 acres on National forest. Estimated cost is $3,516,000 for technical assistance and $14,158,000 for installation. Implementation of this practice will meet 66 percent of the total needs (Table VIII-15).

Fire Protection

All forest land is under organized fire protection. With a fire loss index of 0.25 percent, 11,000 acres or less is considered an acceptable acreage loss goal. Fire is always a potential threat to the forest resources. This threat will vary with the cover conditions, topography, weather, season and fire behavioral patterns. Adequate suppression forces and equipment are available and future needs will be subject to reappraisal as conditions change.

Watershed Protection

There are approximately 2,600,800 acres or 59 percent of all the forest land scheduled to receive varying degrees of sheet erosion control, gully stabilization, skid trail and logging road maintenance, mined area stabilization and streambank stabilization. Estimated cost is $373,000 for technical assistance and $915,000 for installation. Implementation of this program will meet 96 percent of the total needs. (Table VIII-15).

Forest Grazing Protection

There are approximately 507,000 acres or 11.5 percent of the forest land recommended for protection from grazing by fencing open grazing areas from adjacent forest land. This practice would greatly improve the growing stock and conditions of the forest land. Estimated cost is $223,000 for technical assistance and $2,109,000 for installation. Implementation of this program will meet 33 percent of the need to remove cattle on private land to improve forest growing stock. (Table VIII-15).

General Forestry Assistance

Highly specialized technical forest management assistance is available to landowners and is served by other programs. These programs might include forest product processing advise, urban forestry programs, and forest management of flood plains.

Rural Development Programs

No large scale projects under Resource Conservation and Development, Rural Renewal, Rural Area Development or similar USDA programs have been developed and none are currently being planned. Two recent developments will provide new opportunities for combining and broadening the objectives of numerous local small-scale projects which will continue to require services provided by USDA programs.

The Rural Development Program has been initiated to provide an organizational tool for coordinating USDA efforts. In Virginia, under this program, representatives of USDA agencies and representatives of State and local agencies will comprise a State Resource Council. The Council will provide guidance for determining needs for public and private development to improve the social, economic, and environmental conditions in rural areas. Federal, State, and local agency representatives will furnish information on the services and resources available. The Council will serve as a clearing house to help define objectives to suggest priorities and to outline procedures for the optimum utilization of all public and private services and resources to achieve objectives.

Also in Virginia, recent legislation led to the establishment of multiple county and city planning and service districts. The purpose of these districts is primarily to provide the means for more efficient large-scale development of public service facilities such as water supply and waste disposal.

Both these programs will broaden the opportunities and needs for services of USDA agencies. Achievement of common or related objectives will depend to a large extent on the orderly development and management of land and water resources. This will mean new challenges and opportunities for cooperation and coordination of USDA services in both rural and urban areas.

Recreation Plan

One of the basic objectives of a comprehensive river basin study, of which this plan is a part, is to define or evaluate programs and

projects that are needed within the next 10 to 15 years (early action time frame) to provide solutions to the Basin's most pressing water and related land problems.

The early action plan must address itself to the key element which will most logically and efficiently do the job at hand. Programs and projects considered for implementation after 15 years are long range and are, therefore, not justifiable or feasible under existing conditions.

Features of the recreation plan include:

1. Development of public recreation facilities at proposed small watershed and Corps of Engineers reservoir projects.

2. Implementing the Scenic Rivers Act following the recommendations contained in the Virginia Scenic Rivers Report and studying other rivers for inclusion into the Scenic Rivers System.

3. Expanding the present recreation capability of the Basin's lakes and impoundments and on streams not proposed as scenic rivers.

4. Expanding the present State Natural Areas System to preserve additional examples of natural earth types, including areas of ecological faunal, floral, geological marine, or aquatic significance.

5. Preserving identified historic features that complement existing or proposed recreational areas, giving emphasis to those places identified on the Virginia Register of Landmarks and on the Register of Historic Landmarks.

6. Implementing a Virginia Scenic and Historic System.

7. Implementing the Virginia Scenic and Historic Road System.

8. Implementing the Virginia Recreational and Scenic Trail System and coordinating with Appalachian National Scenic Trail.

9. Improving and expanding existing areas and facilities at all levels of government and private enterprise.

10. Creation of new areas and facilities at all levels of government and private enterprise.

Small Watershed Multipurpose Reservoir Facilities

Proposed multiple-purpose reservoir projects will generally support most water and land related recreation activities in the Appalachia subarea, except power boating and water skiing. However, problems may arise in considering specific proposals intended to meet needs within

the watershed other than recreation. Reservoirs and/or stream channelization may cause loss or damage to existing recreation values and the natural environment. Table VIII-16 list reservoirs selected which could provide recreation opportunity.

The development of the proposed small watershed impoundments would support approximately 245,400 annual recreation days initially and 284,400 ultimately. Cowpasture River Structure 12-12 (1B), a multipurpose reservoir, has not been considered because of conflict with the Bullpasture Scenic River Proposal.

Table VIII-16. Proposed small watershed multiple-purpose reservoir projects, Appalachia Subarea, James River Basin

Watershed	Structure Number ( )	Acreage: Land	Acreage: Water	Annual Rec/Day Capacity (1,000's): 1980	2000	2020
Upper Jackson River, 12-6,7	12-6(1G)	390	489	78.0	97.5	117.0
Calfpasture 12a-1	12a-1 (6)	53	53	21.2	21.2	21.2
Potts Creek 12-9,10,11	12-10 (6)	40	50	20.0	20.0	20.0
	12-11 (1A)	125	254	76.2	76.2	76.2
Catawba Creek 12-22	12-22 (7)	100	127	50.0	50.0	50.0
Total		708	973	245.4	264.9	284.4

Three multiple-purpose small watershed projects are proposed for construction in the early action time frame in the Appomattox subarea. Five reservoir projects would be added by 2020. Initial reservoirs would be capable of providing 162,000 recreation days annually and by year 2020, with the additonal construction, the small watershed program will provide an estimated 459,600 recreation days annually (Table VIII-17).

The proposed multiple-purpose projects are small but will support most water based recreation activity except power boating and water skiing.

One small watershed multiple-purpose reservoir is proposed for construction during the early time frame in the Richmond subarea,

Table VIII-17. Proposed small watershed multiple-purpose reservoir projects, Appomattox Subarea, James River Basin

Watershed	Structure No. ( )	Acreage Land	Acreage Water	Annual Rec/Day Capacity (1,000's) 1980	2000	2020
Tye River, 12-25	12-25(4)	50	62	24.8	24.8	24.8
Piney River, 12-26	12-26(3)	110	143	57.2	57.2	57.2
Hardware River, 12-30	12-30(2A)	200	134	80.0	80.0	80.0
Rock Fish Creek, 12-23,24	12-23(2)	120	185	-	77.2	77.2
	12-23(3)	130	146	-	58.4	58.4
	12-24(1)	130	159	-	63.6	63.6
Bent Creek, 12-41	12-41(1A)	177	274	-	-	42.4
Wreck Island Creek, 12-42	12-42(3)	234	350	-	-	56.0
Total		1,151	1,453	162.0	361.2	459.6

seven by the year 2000, three more by 2020. Initial development will provide an estimated 74,900 recreation days annually and 1.6 million by 2020 if all sites are developed (Table VIII-18). The reservoirs are capable of supporting a wide range of water oriented recreation activities.

No small watershed multiple-purpose reservoir projects were considered for development in the Norfolk subarea.

Table VIII-18. Proposed small watershed multiple-purpose reservoir projects, Richmond Subarea, James River Basin

Stream Name & CNI Watershed Numbers	Structure Number ( )	Acreage Land	Acreage Water	Annual Rec/Day Capacity (1,000's) 1980	2000	2020
North Fork Rivanna River 12b-1,2,7,12	12b-12(11)	332	416	74.9	116.5	116.4
Beaver Dam Creek, 12-50	12-50(1A)	246	246	-	123.0	123.0
South Fork Rivanna River, 12b-3,4,5,6,13, 14	12b-4(1B)	292	438	-	75.0	125.1
	12b-6(4B)	146	182	-	72.8	72.8
Upper Appomattox River,12c-1,2, 12	12c-1(4A)	466	680	-	75.0	177.0
Middle Appomattox River, 12c-3,4	12c-3(11B)	700	1,049	-	75.0	245.0
	12c-4(1C)	667	1,000	-	75.0	235.0
	12c-4(5B)	1,038	734	-	75.0	260.0
Byrd Creek, 12-44	12-44(3)	234	252	-	-	56.0
Flat Creek, 12c-6,9,13,14	12c-6(1B)	775	1,082	-	-	75.0
	12c-9(1B)	830	1,246	-	-	75.0
Total		5,726	7,325	74.9	687.4	1,610.3

CHAPTER IX

IMPACTS OF USDA PROGRAMS

This chapter is devoted to a discussion of the impacts of the opportunities for development under USDA programs outlined in Chapter VIII. Technical assistance programs of aid to individuals and small groups are expected to be substantially more effective. The general discussion below summarizes the anticipated effects of these continuing and ongoing programs.

The remainder of the discussion is directed primarily to the effects of the 12 early action PL-566 projects. Even these potential projects will be carefully weighed with alternative solutions before the projects, or elements of the projects, will be selected to be included in the comprehensive plan for development in the Basin.

The 14 intermediate and long range projects suggested for development after 1980 will be subject to even more rigorous re-examination. Because of the probable modification or even elimination of some of these projects prior to implementation, no discussion of physical and biological effects and only a summary of economic impacts is included.

General Effects and Impacts

Land Use and Conservation Programs

Impacts of land treatment and conservation measures applied under long established USDA programs will continue to be realized throughout the Basin. These programs primarily provide advisory services and technical assistance to individuals or small groups of farmers for planning and application of onfarm conservation measures. Such measures as conservation rotations, improved vegetative cover, terracing, contour farming, sod waterways, crop residue management, improved wildlife habitat and management, and forest land improvement practices have been universally conceded to effect favorable environmental impacts. So much so that these accomplishments of farm owners and operators have been largely unheralded and uncounted. For this report it was considered a needless exercise to compute and tabulate the Basin-wide impacts of these measures. The past and continuing effects of these measures will continue to have an overwhelmingly favorable impact on fish and wildlife, water quality, recreational, scenic and other environmental values.

Minor adverse effects on fish and wildlife have resulted from onfarm drainage of bottomlands. In the Basin, this usually involves relatively small areas to allow more efficient use of machinery; and on somewhat larger areas to assure that excess water will not destroy crops or preclude use of machinery in the harvest season.

Added emphasis is being directed to encourage landowners toward preservation of wetland wildlife habitat in their decisions on land use, and adverse effects are expected to continue to be minimal.

The extension of services of USDA programs to urbanizing and other construction areas will have favorable but indeterminate impacts. As discussed in Chapter VI, an increasing number of State and local councils are requesting assistance in framing erosion and sedimentation ordinances; interpretation and soils data for land use planning and zoning; delineation of flood hazard zones; and similar services. This will allow tools and techniques previously applied on agricultural lands to effect favorable impacts in these developing areas.

Land Use Conversions

As indicated in previous discussions, availability of land will not be a limiting factor in resource development. USDA programs will be quite effective in promoting the use of land according to its capability (Appendix A). For example, with cropland acreage declining the amount and distribution of Class I and Class II is more than adequate to allow all crops to be grown on these soils. Conversely, elimination of cultivated crops from Classes III through VII will allow these soils to be devoted to less hazardous and less intensive use.

In the proposed PL-566 projects, flood protection will allow more efficient agricultural use of flood plain lands. This will also permit crops and other intensive uses to be shifted to these protected and more productive areas. Less hazardous uses such as pasture and forests can be shifted to the steeper uplands.

Fifty-eight percent or 2.1 million acres of the forest land is in land capability classes I through IV (Table IX-1). Of this 2.1 million acres, 77 percent or 1.6 million acres are in the Piedmont and Blue Ridge, 18 percent or 0.4 million acres lies in the Coastal Plains, and 5 percent or 0.1 million acres lies in the Ridges and Valleys. With almost half of the total forest land in high capability classes, the future of the forest resources will depend more on how these lands are used. Certainly, economic competition from both urban development and crops which produce a high income will be factors which could possibly change this land use from forestry. Forest land management decisions should give priority to development of these high capability classes to maximize multiple forest uses and production capabilities.

Unfortunately, USDA programs will not be as effective in their influence on non-agricultural land use. Progress will continue to be slow in the adaptation of USDA land use and conservation techniques in urban, industrial, and highway construction areas.

Table IX-1. Forest land area by capability classes and physiographic areas 1/, James River Basin

Land Capability Classes	Coastal Plain	Piedmont and Blue Ridge	Ridges and Valley	Total
		1,000 acres		
I (0.2)	6.3	1.4	-	7.7
II (20.2)	233.9	633.5	21.8	889.2
III (18.0)	116.1	633.7	41.1	790.9
IV (9.3)	27.5	342.2	39.5	409.2
V (0.8)	6.5	30.2	-	36.7
VI (20.3)	34.8	387.5	473.7	896.0
VII (31.0)	100.2	366.8	896.3	1,363.3
VIII (0.2)	5.4	2.4	2.7	10.5
Total	530.7	2,397.7	1,475.1	4,403.5
Percent	(12.1)	(54.4)	(33.5)	(100.0)

1/ Conservation Needs Inventory plus Federal lands.

Competition will increase for control of the more level lands such as the protected flood plains.

Complex economic and social problems preclude rapid progress in preserving the best adapted land for agricultural use. Hopefully, greater coordination of both public and private efforts will effect greater progress than anticipated in this area. Incentives may be provided to encourage private interests to preserve open spaces in urban and industrial areas, to promptly revegetate denuded construction areas, to use silt basins and other sediment control measures during construction and generally to adopt proper land use and conservation measures in their operations.

If incentives fail to discourage development in the flood plain, land use regulations are an alternative which may be used. The SCS is currently conducting Flood Hazard studies to provide technical information necessary to establish adequate land use regulations.

Prospective Timber Inventory

The Blue Ridge Parkway is totally withdrawn from timber production and hunting pressures. It's total present use is recreation and aesthetics. These management objectives will continue in the future.

The George Washington and Jefferson National Forests will continue to be managed for their total resources. Demands on these forest lands to produce more goods and services are increasing rapidly. Conflicts in their use have resulted in the need to develop "unit" plans. A unit is a subdivision selected for managing all resources without impairment, within the capabilities of the land to meet different demands simultaneously. Particular unit plans will result in exclusive uses in some areas, both primary and secondary uses in others, and still other areas will be managed for general-use with no primary exclusions. Even though management will be intensified, this advent in the management of local National forests will probably not result in any appreciable relative increase in timber production because soil capabilities are more limiting.

Forest industries will continue to manage their land primarily for timber production while supplementing hunting and recreation demands.

Private forest lands which are the largest ownership class in the area, represent the greatest multitude of management objectives. These private forest tracts, predominantly in the Piedmont and Coastal Plains, possess the greatest capability for meeting a mix of demands on the forest resources.

Under the present level of management on all forest land, the expected inventory of growing stock for all species will increase 34 percent from 4,072 million cubic feet in 1965 to 5,442 million cubic feet in 2020 (Table IX-2). Hardwoods, which comprise 70 percent of the total growing stock volume, will show significant increases through 2020. However, softwood growing stock volume is expected to remain virtually the same as the 1965 level. Sawtimber volume for all species is expected to increase 18 percent from 10.4 billion board feet in 1965 to 12.2 billion board feet by 2020. Eighty-two percent of the 18 percent increase will be hardwood sawtimber.

An accelerated level of forest management would retain the present softwood cover, add 30 percent of the present oak-pine cover to softwood, increase trees five inches (diameter breast high) and larger from present 60 square feet to 90 square feet of basal area, increase average net growth of growing stock from 35 cubic feet per acre annually to 70 cubic feet, through timber stand improvement increase by at least 20 percent the proportion of all live trees that qualify as growing stock, and reduce the annual mortality

Table IX-2. Comparison of prospective[1/] and potential[2/] inventory of sawtimber and growing stock on commercial forest land, by species groups and projections to 1980, 2000 and 2020

Species Group	Growing Stock				Sawtimber			
	1965	1980	2000	2020	1965	1980	2000	2020
	million cubic feet				million board feet			
Softwoods:								
Prospective Inventory	1,120	1,187	1,228	1,226	3,077	3,432	3,516	3,411
Potential Inventory	1,120	1,321	1,564	1,772	3,077	3,801	4,721	5,539
Percent Increase	0	11.3	27.4	44.5	-	10.7	34.3	62.4
Hardwoods:								
Prospective Inventory	2,952	3,576	4,091	4,216	7,284	8,506	9,120	8,843
Potential Inventory	2,952	3,748	4,842	5,926	7,284	9,114	11,612	14,068
Percent Increase	0	4.8	18.3	40.0	0	7.1	27.3	59.1
All Species:								
Prospective Inventory	4,072	4,763	5,319	5,442	10,361	11,938	12,636	12,255
Potential Inventory	4,072	5,068	6,406	7,699	10,361	12,915	16,333	19,608
Percent Increase	0	6.4	20.4	41.5	0	8.2	29.3	60.0

1/ Estimated inventory based on recent progress in forest management.

2/ Estimated inventory based on accelerated forest management by 2020: retaining present softwood cover plus adding 30 percent of present oak-pine cover to softwood; increase all live trees 5 inches (diameter breast high) and larger from present 60 square feet to 90 square feet basal area; increase average net growth of growing stock from 35 cubic feet per acre annually to 70 cubic feet; increase by at least 20 percent the proportion of all live trees that qualify as growing stock through timber stand improvement; and reduce annual mortality rate by half.

rate to half by 2020. The impact of such an accelerated forestry program is expected to increase the inventory of growing stock for all species by 89 percent from 4,072 million cubic feet in 1965 to 7,699 million cubic feet by 2020. Hardwood growing stock volume is expected to increase 100 percent by 2020 over the 1965 level. Softwood growing stock volume is expected to increase 58 percent by 2020 over the 1965 level. Sawtimber volume for all species is expected to increase 89 percent from 10.4 billion board feet in 1965 to 19.6 billion board feet by 2020. Seventy-three percent of the 89 percent increase will be hardwood sawtimber.

Social and Institutional

USDA projects provide additional benefits to those evaluated in the study. Especially in the Appalachian Region of the Basin, these projects will improve the social and institutional qualities through the creation of a better environment. The addition of municipal and industrial water storage, recreation facilities and flood protection will offer opportunities that should improve the well being of the people. Monetary values were not assigned to these intangible benefits but they will add significantly to overall project justification.

Recreation

The suggested small watershed level of development in the Appalachia subarea would provide for 245,000 annual recreation days by 1980 and 284,000 annual recreation days by 2020 (Table IX-3).

Table IX-3. Summary, annual outdoor recreation day needs satisfied by recreation plan by subarea, James River Basin

Subarea	Annual Recreation Days (1,000's)		
	1980	2000	2020
Small Watershed Impoundments:	245.0	265.0	284.0
Appalachia	245.0	265.0	284.0
Appomattox	162.0	361.2	459.0
Richmond	74.9	687.3	1,610.3
Norfolk	-	-	-
Total	481.9	1,313.5	2,353.9

Source: Preliminary Outdoor Recreation Report, USDI, BOR-1972

The suggested small watershed level of development in the Appomattox subarea could provide for 162,000 recreation days annually by 1980 and 459,000 days by 2020. The needs satisfied will depend on the effective utilization of the structures which are constructed.

The suggested small watershed level of development in the Richmond subarea will provide an estimated 74,900 recreation days

annually by 1980 and 1,610,300 recreation days annually by 2020. The needs to be satisfied in this subarea and the Norfolk subarea are very urban oriented.

There are no small watershed impoundments suggested for the Norfolk subarea. The supply in this subarea is dependent on the development of existing water surface areas.

Needs in the Basin satisfied by small watershed impoundments are estimated to be 481,900 recreation days annually in 1980 and 2,353,900 recreation days in 2020. In total, small watershed impoundments will add 7,585 acres of land and 9,851 acres of water to the existing recreation supply.

Physical and Biological Effects of Early Action Projects

Hydrology

The basic element of USDA resource development projects is proper land use and treatment. The acreage of accelerated land treatment included in the 12 PL-566 early action projects is tabulated in Table VIII-4.

Improvement in land treatment will effect significant reductions in runoff from low intensity storms of short duration. Better hydrologic conditions will increase rates of evaporation and transpiration and cause modest reductions in water yields. Increased infiltration will increase and delay subsurface flows which will tend to increase and prolong low flows in surface streams, as well as decrease flood peaks.

Table IX-4 provides an indication of the effect of improved land treatment on flood runoff in the three subareas. Effects on specific areas will vary with the land use, the range of improvement and other factors. Conversion of cropland to grass could reduce the volume and rate of surface runoff dramatically in one year's time. Land already in forest might require several years to show a measurable reduction in runoff. The improvements from agricultural land treatment will vary widely from watershed to watershed and in some watersheds will be offset to a minor degree by nonagricultural developments such as highways and increased use around recreational developments.

Structural measures in the 12 early action PL-566 projects at the suggested level of development include 57 floodwater retarding structures and 42.2 miles of channel improvements. The floodwater retarding structures will control runoff from 678.0 square miles which would average 38 percent of the drainage area of each project.

Table IX-4. Benefits to be derived from accelerated forest land treatment program, James River Basin

Land Resource Area	Soil Loss w/ Present Treatment 1/	Reduction in Soil Loss Rate w/Accel. Treatment 2/		Flood Runoff Reduction 3/	
	Tons/Ac/Yr	Tons/Ac/Yr	Percent	Inches	Percent
Ridge and Valley LRA* 128	1.20	0.24	20	0.19	15
Piedmont-Blue Ridge LRA*136,148,130	0.60	0.08	13	0.13	11
Coastal Plain LRA*133,149	0.28	0.02	7	0.07	6

* Land Resource Area

1/ North Atlantic Regional Water Resources Study.

2/ Upland Sheet Erosion Rates computed using Musgrave Soil Loss Prediction Equation.

3/ Based on 100-year frequency storm of six-hour duration (five-inch rainfall).

Structural measures and associated land treatment in these projects would eliminate flooding or reduce the depths of flooding on 25,190 acres below floodwater retarding structures during the 100-year frequency storm. Table IX-5 shows total acres flooded with and without the potential projects for the 100-year and 5-year frequency storms.

The 42.2 miles of channel improvements were included as the least costly measures to achieve the tentative objective of 5-year flood free protection to the total flood plain below dams. It is anticipated that when final plans and specifications are prepared, a lesser degree of flood protection will be considered adequate in some reaches to meet objectives of the local people. The channel improvements are not expected to significantly affect stream flows except to reduce depths of flooding in the limited reaches where measures are eventually installed.

Sedimentation

The effects of land treatment will be to reduce gross erosion and resultant sedimentation. Beneficial impacts extend beyond reductions in the loss of topsoil and consequent losses in productivity. Results of reduced sedimentation include better water quality, less clogging of channels, and reductions in the siltation of reservoirs and infertile overwash on flood plains. The extent of the effect of land treatment on sedimentation, as on hydrology, will

Table IX-5. Flood plain acres inundated in PL-566 projects, James River Basin

Watershed	Flood plain inundated (acres) By 100-year flood w/o Project	Flood plain inundated (acres) By 100-year flood w/Project	Flood plain inundated (acres) By 5-year flood w/o Project	Flood plain inundated (acres) By 5-year flood w/Project
Early action (1980):				
Ogle Creek, 12-3	460	200	230	45
Dunlap Creek, 12-4,5	1,860	1,610	1,340	820
Upper Jackson River, 12-6,7	2,075	1,260	1,310	650
Cowpasture River, 12-12,13,14	6,700	5,200	5,270	3,760
Jackson River 5, 12-15	375	190	165	5
Tye River, 12-25	2,560	1,760	1,735	200
Piney River, 12-26	1,110	440	530	0
Hardware River, 12-30	2,130	1,700	1,650	1,040
James River 5, 12-36	930	540	430	0
Beaver Creek, 12-43	500	400	320	80
Calfpasture River, 12a-1	4,460	2,790	2,670	950
North Fork Rivanna River, 12b-1,2,7,12	2,030	1,590	1,780	0
Subtotal	25,190	17,680	17,430	7,640
Intermediate action (2000):				
Potts Creek, 12-9,10,11	1,845	1,075	1,070	215
Catawba Creek, 12-22	1,670	1,465	1,240	0
Rockfish River, 12-23,24	1,995	1,585	1,370	480
Beaverdam Creek, 12-50	570	270	460	0
Hays Creek, 12a-3	840	555	550	120
South River, 12a-6	1,500	465	605	40
South Fork Rivanna River, 12b-3,4,5,6,13,14	2,580	1,080	1,765	0
Upper Appomattox River, 12c-1,2,12	6,725	5,555	5,175	0
Middle Appomattox River, 12c-3,4	7,060	5,640	6,330	0
Subtotal	24,785	17,690	18,565	855
Long range action (2020):				
Bent Creek, 12-41	530	230	260	0
Wreck Island Creek, 12-42	1,200	715	875	0
Byrd Creek, 12-44	3,350	2,700	2,570	150
Lower Appomattox River, 12c-5,8	11,780	10,510	9,470	0
Deep Creek-Flat Creek, 12c-6,9,13,14	4,440	2,920	4,070	0
Subtotal	21,300	17,075	17,245	150
Total (1980-2020)	71,275	51,445	53,240	8,645

Source: Watershed Investigation Reports.

depend on the range of improvement and will vary widely from watershed to watershed.

Accelerated land treatment would be applied on about 190,000 acres (Table VIII-1) in the 12 PL-566 early action projects. Table IX-4 indicates the effect of improved land treatment on erosion rates and resultant sedimentation downstream. The probable annual soil loss reduction would average about 20 percent or an estimated 150,000 tons per year[1/] on these agricultural and forest lands. Conversion of cropland, especially on steeper slopes, to less hazardous uses and similar trends in agricultural use under related programs will effect added reductions in gross erosion. The sediment delivery ratio will not change significantly and sediment yields in downstream areas would be reduced in proportion.

Little urbanization is anticipated in the early action watersheds, but the reductions discussed above will be offset to a minor extent by rural residential, recreation, and similar developments. Localized and temporary sedimentation will occur during and immediately following installation of project structural measures despite strict specifications to control erosion and sediment and to assure prompt revegetation.

Final plans and specifications of channel improvements will include controls to also minimize sedimentation following installation. Actual excavation or enlargement will be included only after thorough study indicates the need to meet project objectives and after careful consideration of environmental effects. Established procedures require that binding agreements for proper maintenance be executed prior to installation of structural measures. With such precautions, no drastic changes in onsite erosion or downstream sedimentation is expected to result from installation of these measures.

The 57 floodwater retarding structures included in the early action projects will provide 25,375 acre-feet of sediment storage in addition to the flood detention and beneficial storage. This would provide storage for about 50,000 tons of sediment each year during the economic life of the structures.

Water Quality

The major effects of USDA programs on water quality will result from net reductions in sedimentation. The extent of these impacts are indicated above.

1/ Based on average conditions in the Ridges and Valleys and Blue Ridge-Piedmont subareas and acreage of cropland, pasture, and forest land suggested for accelerated treatment.

Reduced turbidity will enhance fishing, swimming, water recreational and other environmental values. The quality of public water supply systems fed by these upstream watersheds will be improved as sedimentation of reservoirs is reduced.

No storage for water quality control is included in the early action PL-566 projects. If future detailed studies indicate such needs, storage capacity is ample in most proposed reservoir sites to add this storage.

Possible adverse effects on water quality with respect to fish and wildlife are discussed below.

Fish and Wildlife. The favorable impacts of USDA land treatment programs on fish and wildlife are indicated above. Better hydrologic conditions would prolong and increase low flows and reduce the volume and rate of flood flows. These effects coupled with net reductions in sedimentation will result in more moderate flows, clearer water and generally more favorable biological conditions in streams and on the land. Proper harvesting of forest products will provide additional browse and diversity of ground cover for forest game species. These factors will offset minor losses such as grain food supplies from reduction of cropland.

Existing fish and wildlife values will be lost in 3,835 acres at the suggested normal pool levels of the 57 floodwater retarding and multipurpose reservoirs of the early action projects (Table VIII-5). Most of these bottomlands are in general agricultural use or forest. Fence rows and wooded streambanks afford other wildlife habitat. Brushy wetland areas are usually included in adjacent pasture fields. Quality as wildlife habitat is rated generally fair to good. These areas represent about .3 of 1 percent of the area of the early action watersheds.

These normal pools would inundate about 45 miles of existing streams including about 15 miles (75 acres) of put-and-take trout streams. Approximately 15 miles afford little or no fishing because of undependable flows especially during the summer months. The remainder is rated generally fair to good for warm water species.

The discussion below is considered necessary because of the recent public outcry against the type of structural measures included in potential PL-566 projects. Also, comments on the draft report indicate a lack of understanding of prescribed procedures which provide safeguards to preclude extremely adverse impacts on the environment.

The above estimates and qualitative analyses are based on a four-week field study which included only about half of the 57 sites suggested for development in the early action projects (Appendix B).

The report indicates that five of the reservoir sites studied could be developed and managed to provide 576 acres of good quality put-and-take trout fisheries. Cold water releases will be included in some of the structures to offset the warming effect on downstream waters. These and other opportunities for mitigating fish and wildlife losses can be considered in formulating the comprehensive plans.

Another 4,733 acres of wildlife habitat and about 25 miles of additional streams will be subject to intermittent flooding in the flood detention pools of the structures. This will cause disruption of existing ecosystems in these areas.

Recent guidelines emphasize public access and management of these reservoirs. Past and present conditions effectively deny public access to most of the stream fisheries in the area. This indicates that implementation of these projects could expand the fishing opportunities available to the public.

<u>Channel Improvements</u>

About 42 miles of channel improvements appear necessary in the 12 early action projects. Twenty-three miles of this would be brushing and snagging and 19 miles is suggested for actual physical alteration to meet the tentative objective of 5-year frequency flood free protection on flood plains below floodwater retarding structures.

Recently, public criticism has alleged widespread and severe adverse effects of certain practices carried out with technical and financial assistance of USDA and other programs. Channel improvements, endorsed by local sponsors to meet flood protection needs, are said to cause drastic and destructive impacts to fisheries and wildlife habitat. Such publicity promises to have a net favorable effect in future projects and programs. Procedural safeguards have been strengthened to assure that full and frank evaluation of benefits and effects of these measures is made available to decision makers. The anticipated effects are that more careful study will further minimize or mitigate the alleged adverse impacts.

Indiscriminate implementation of channel improvement measures could cause drastic adverse effects to fisheries and wildlife habitat along streambanks in these reaches and damage to downstream fisheries. However, as discussed above, these measures will be subject to rigorous reexamination and restudy prior to implementation. Objectives can be modified to limit the extent or eliminate the need for some of the measures. Final specifications will provide for utmost discretion in preserving shade, vegetation, pools, riffles and other values in brushing and snagging operations. The same degree of caution will be exercised to minimize damages resulting from channel alterations included in the final plans for development. Requirements for sloping streambanks, prompt revegetation, and streambank fencing to exclude livestock could result in a net

Channel Improvement - Nelson County, Virginia, two years after restoration. Channel was completely obliterated during Hurricane Camille in 1969.

reduction in streambank erosion in these areas. The photo on this page shows these measures applied in a "channelized" reach of a stream in Nelson County about two years after installation. The photo also shows the ponding effect of the island in the foreground and riffles in the divided channel on either side of the island. Other mitigating measures such as ox-bow meanders and artificial hiding areas will be considered to minimize losses of existing values.

Recreation

As indicated above, the normal pools of early action structures will make 3,835 acres available for recreational use. The extent of recreational opportunities afforded will depend on final decisions as to the level of development for that purpose that will be compatible with flood protection and water supply needs and which reservoirs will be made accessible to the public.

The Appendix on Recreation to the comprehensive plan includes thorough discussion of the impacts of these and other projects on the recreational aspects of the Basin.

Economic Impacts

The following data and discussion briefly summarizes the probable economic impacts of the opportunities for development evaluated in this report. No final and detailed assessment of impacts was warranted for several reasons. The proposed measures and projects must yet be considered with other opportunities for meeting needs before being included in the comprehensive plan for the Basin. Suggested levels of development may be modified or extended. Discount rates, prices, costs, and other economic factors have changed since the original evaluations were made. Needs and objectives of the local people could change. The data presented does indicate the effects of USDA programs for the conditions and values used in making the evaluations. Appendix C also contains considerable detailed data on the early action projects which will be helpful when reassessment of economic and environmental effects is necessary.

General Assistance Programs

The economic justification of ongoing advisory, technical, and financial assistance programs of USDA is well established. The multiplying economic impacts of proper land use and treatment extend beyond the local community and effects accumulate into the future as long as the practices are maintained. The broader and more effective opportunities anticipated under these programs will promote additional favorable impacts on the general economy.

Implementation of recently enacted State and local statutes promises to bring about more stable economic patterns with respect to land values. Proven tools and techniques of USDA programs for adapting land use to capability and suitability are being adopted by land use planners in urban areas. Economic losses from floods will be reduced by zoning and restrictions on developments in flood plains. Beginnings are being made to overcome the complex obstacles for preservation of open space, parks, and greenbelts in urbanizing areas. Ordinances for control of erosion and sedimentation in construction areas are being implemented under new State legislation. As in agricultural areas, favorable long range benefits will be realized in reductions of flood and sediment damage and net overall effects on land values and the tax base.

Short term adverse economic effects will result in those areas where development is restricted. Landowners and developers may not realize anticipated profits. Costs for control of erosion and sediment in construction areas will be added to residential and other developments. Parks and other "non-productive" areas become liabilities from the viewpoint of officials concerned with collection and disbursement of tax funds. This brief discussion of economic factors provides a slight insight into the problems

involved to meet the demands for material necessities and in using the same resources to provide the aesthetic and recreational needs of all the people.

Summary of Total Impacts of PL-566 Projects

The economic impacts of the 26 potentially feasible PL-566 projects are indicated in Table IX-6. Direct monetary benefits attributable to structural measures are tabulated for flood prevention, water supply, and recreation. Generally indirect economic effects are shown as secondary and redevelopment benefits.

Table IX-6. Summary of average annual benefits, potential PL-566 projects, James River Basin

Priority Category	Average Annual Benefits: Flood Prevention 1/	Water Supply	Recreation	Redevel. & Secondary 2/	Total Benefits
	Thousands of Dollars 3/				
Early Action	1,582.9	153.8	970.2	511.7	3,218.6
Intermediate Action	1,317.6	225.7	2,525.3	498.5	4,467.1
Long Range Action	514.4	19.5	1,413.8	194.8	2,142.5
Total	3,414.9	399.0	4,909.3	1,205.0	9,828.2

1/ Flood prevention benefits includes damage reduction, more intensive land use, changed land use, incidental recreation and benefits to sediment stored in structures.

2/ Broadly, value of benefits from increased economic activity generated as a result of project installation.

3/ Price base 1967.

No estimates are shown for intangible benefits such as prevention of loss of life or other benefits not readily measurable in monetary terms. These would include increases in economic opportunities for low income groups and family farm operations. Other examples are benefits resulting from enhancement of cultural, safety, health, and other environmental values. Intangible benefits may be considered under certain conditions for justification of individual projects where economic feasibility may be questionable.

They may be an important element of project justification in that portion of the Appalachian Redevelopment Area in the James River Basin.

The costs of structural measures shown in Table VIII-3 are generally regarded as adverse economic effects. Included are the loss of productivity and other values in the reservoirs and construction areas, and the irretrievable costs of material, labor, and fuel for installation and maintenance.

Comparison of monetary benefits and costs are shown in Table IX-7 with installation costs computed for three discount rates. The overall benefit-cost ratio appears favorable in each priority category, but individual projects may require more detailed study.

Table IX-7. Summary of comparison of benefits and costs of structural measures 1/, potential PL-566 projects, James River Basin

Priority Category	Average Annual Benefits	Average Annual Costs 2/			Benefit-Cost Ratio 3/		
		5-5/8%	5-7/8%	7%	5-5/8%	5-7/8%	7%
	Thousands of Dollars						
Early Action	3,218.6	2,649.9	2,749.7	3,217.7	1.21:1	1.2:1	1.0:1
Intermediate Action	4,467.1	3,590.4	3,710.6	4,253.7	1.24:1	1.2:1	1.1:1
Long Range Action	2,142.5	1,581.4	1,632.3	1,863.1	1.35:1	1.5:1	1.2:1
Total	9,828.2	7,821.7	8,092.6	9,334.5	1.25:1	1.2:1	1.1:1

1/ Price base 1967.

2/ Installation costs amortized for 100-year economic life at indicated discount rates plus annual operation and maintenance.

3/ Economic feasibility evaluations in this report are based on 5-5/8 percent discount rates for amortization of installation costs. 5-7/8 percent and 7 percent columns indicate effects of higher discount rates on benefit-cost ratio.

Impacts of Early Action Projects

Table IX-8 provides an indication of the economic impacts of each of the 12 early action PL-566 projects. Installation costs of structural measures at suggested levels of development for each project are shown in Table VIII-6. Table IX-9 shows the comparison of monetary benefits and costs with installation costs computed for three discount rates. The format for these tables is the same used

Table IX-8. Average annual benefits, structural measures, potential PL-566 early action projects, James River Basin

Watershed	Average Annual Benefits: Flood Prevention	Water Supply	Recreation	Redevel. & Secondary 1/	Total 2/
	Thousands of Dollars 3/				
Subarea 1					
Ogle Creek (12-3)	94.1	17.0	0	33.2	144.3
Dunlap Creek (12-4,5)	86.8	17.0	0	38.7	142.5
Upper Jackson (12-6,7)	135.5	12.0	235.3	91.6	474.4
Cowpasture River (12-12,13,14)	359.1	8.4	252.6	163.2	783.3
Jackson River (12-15)	111.2	35.8	0	51.0	198.0
Tye River (12-25)	178.3	5.0	32.2	21.5	237.0
Subtotal	965.0	95.2	520.1	399.2	1,979.5
Subarea 2					
Piney River (12-26)	135.8	8.4	74.4	21.8	240.4
Hardware River (12-30)	87.0	6.4	166.8	26.0	286.2
James River 5 (12-36)	54.4	5.4	0	5.9	65.7
Beaver Creek (12-43)	31.5	4.3	0	3.6	39.4
Calfpasture R. (12a-1)	183.6	21.8	31.8	23.7	260.9
North Fork Rivanna River (12b-1,2,7,12)	125.6	12.3	177.1	31.5	246.5
Subtotal	617.9	58.6	450.1	112.5	1,239.1
Total Early Action Watersheds	1,582.9	153.8	970.2	511.7	3,218.6

1/ Definitions of these terms are in the text, Appendix C.

2/ For total benefits or difference for varying interest rates, the differences are too minor to warrant extra columns on this table.

3/ Price base 1967.

Source: Watershed Investigation Reports, SCS.

Table IX-9. Comparison of benefits and costs of structural measures, potential PL-566 early action projects, James River Basin[1]

Stream (CNI W/S No.)	Average Annual Benefits	Average Annual Costs[2]			Benefit-Cost Ratio[3]		
		5-5/8%	5-7/8%	7%	5-5/8%	5-7/8%	7%
	Thousands of Dollars						
Subarea 1							
Ogle Creek (12-3)	144.3	113.8	118.7	140.8	1.3:1	1.2:1	1.0:1
Dunlap Creek (12-4,5)	142.5	137.9	143.8	170.3	1.0:1	0.9:1	0.8:1
Upper Jackson R. (12-6,7)	474.4	318.8	329.6	378.3	1.5:1	1.4:1	1.3:1
Cowpasture River (12-12,13,14)	783.3	526.5	583.7	679.7	1.5:1	1.3:1	1.2:1
Jackson River (12-15)	198.0	176.7	184.3	218.3	1.1:1	1.1:1	0.9:1
Tye River (12-25)	237.0	245.0	255.1	310.8	1.0:1	0.9:1	0.8:1
Subtotal	1,979.5	1,518.7	1,615.1	1,898.2	1.3:1	1.2:1	1.0:1
Subarea 2							
Piney River (12-26)	240.4	228.6	237.3	277.1	1.1:1	1.0:1	0.9:1
Hardware River (12-30)	286.2	208.7	215.5	246.4	1.4:1	1.3:1	1.2:1
James River 5 (12-36)	65.7	41.4	43.1	50.9	1.6:1	1.5:1	1.3:1
Beaver Creek (12-43)	39.4	36.1	37.6	44.5	1.1:1	1.0:1	0.9:1
Calfpasture River (12a-1)	260.9	275.7	287.0	338.4	0.9:1	0.9:1	0.8:1
N. Fork Rivanna R. (12b-1,2,7,12)	346.5	304.7	314.7	362.3	1.1:1	1.1:1	1.0:1
Subtotal	1,239.1	1,095.2	1,134.6	1,319.6	1.1:1	1.1:1	0.9:1
Total Early Action Watersheds	3,218.6	2,649.9	2,749.7	3,217.7	1.2:1	1.2:1	1.0:1

1/ Price base 1967.

2/ Installation costs amortized for 100-year economic life at indicated discount rates plus annual operation and maintenance.

3/ Economic feasibility evaluations in this report are based on 5-5/8 percent discount rates for amortization of installation costs. 5-7/8 percent and 7 percent columns indicate effects of higher discount rates on benefit-cost ratio.

above for summary of all potential PL-566 projects and the same narrative comments would apply.

The data from preliminary investigation reports in Table IX-9 indicates that justification on the basis of monetary benefits may be questionable in several of these projects. After the projects and measures are selected to be recommended in the comprehensive plan, reevaluation of all individual projects may be necessary, based on the prevailing discount rate, updated costs, and other changing conditions.

CHAPTER X

COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

Coordination

The opportunities for development in upstream watersheds outlined in this report will be weighed with other potentials in formulating comprehensive plan and alternative options to meet the needs of the Basin. The ultimate decision makers must require thorough and careful study and coordination of the alternatives presented to them. To this end, USDA agencies will continue to be available for consultation and interpretation of the report as required.

USDA agencies are receiving an increasing number of requests to participate in coordinated efforts with others in urban and other non-agricultural sectors. This would include such activities as: soils mapping and interpretation for land use planning; control of erosion and sedimentation in construction areas; flood plain zoning and management; and preservation of green belts and open space in urban areas. Chapter VI outlined the contributions that USDA projects and programs can make in these areas.

Alternatives

The first alternative considered in USDA resource development projects is that of limiting suggested action to non-structural measures and alternate uses of flood prone areas. Measures studied, alone and in combination include: conservation land use and treatment; land use regulation; early flood warning systems; flood plain zoning and management; and purchase of flood plain lands and relocation of families, businesses and other improvements.

These considerations in the screening procedure resulted in the selection of USDA potentials suggested for project action as presented in previous chapters. Ongoing programs will provide assistance to localities in the selection and implementation of alternative solutions in the subwatersheds where no project action is suggested.

In preparation of final work plans, alternate systems of floodwater retarding structures and alternate levels of development in individual structures can be evaluated and considered. Dry sediment pools may prove to be more practical than some of the wet sediment or multi-purpose storage pools suggested in the potential reservoirs after further study.

Other alternative solutions must be considered in formulation of the comprehensive plan. For example, projects proposed by other agencies may meet water supply or recreation needs for less cost than PL-566 structures - or environmental impacts may be less in other projects. These and other alternatives must be weighed in decisions on the optional plans to be recommended.

Land Use

Control of land use in the Basin should receive the highest priority by State and local planners. Most of the problems delineated in this report can be at least partially solved through judicious planning of the land resource in the Basin.

Urban development will exert tremendous pressure on the land resource in specific areas of the Basin, i.e. around growing metropolitan centers. Planning to provide for orderly and desirable metropolitan growth should be of the highest priority. Closely associated with this effort is planning for recreational resources and for open space. Provision must be made for industrial and residential development within the constraints imposed not only by recreation and open space, but by flood plain management and drainage considerations.

Provision of needed municipal and industrial water by 1980 will not require large amounts of land. Land use conflicts at individual sites will have a minor impact on overall land use. The loss of the agricultural and/or forest resources will be of minor importance.

If the Basin is to maintain its historical share of food and fiber production in the future, a substantial acreage of agricultural land must be added to the agricultural resource base. This potentially needed land must come from the forest land base. However, many factors must be considered before it is decided that conversion of forest land to agricultural land is the economical thing to do. The Basin's position as a forest products producer appears to be somewhat more important than its position as a food and fiber producer, i.e. its relative advantage as a forest products producer is greater than its relative advantage as a food and fiber producer. It must also be kept in mind that it is costly to clear forest land, the net cost of which must be amortized over the expected life of the new agricultural land. In summary, priority probably should not be given to maintaining the present national share of food and fiber production in the Basin. As the area increases its industrial employment base and as the recreational appeal of the Basin is enhanced, opportunities for the employment

of unemployed and underemployed agricultural labor will increase. Agricultural production will decrease and resources formerly devoted to food and fiber production will be employed elsewhere.

Urban Development

The expansion of urban areas into surrounding non-urban areas, in the absence of strong controls, is inevitable around those cities which are viable growth centers. The State and local governing agencies of Virginia are similar to agencies elsewhere in the U. S.: they exert weak control over the urban development process. Urban development is expected to claim almost 6,000 acres annually with most of the pressure coming in small areas on the rural-urban fringe of such growth areas as Richmond, Charlottesville, Petersburg, Colonial Heights and Hopewell. The State and the urban areas concerned need to take an active, aggressive role in determining shape of future development.

Urban and suburban parks are an extremely important element in the provision of recreational resources for an expanding population. It is stated in this report that the single greatest problem in the provision of recreational resources is locating these resources where they are easily accessible to the potential users. State and local groups should make provision for urban parks before the development process destroys the opportunity.

Open space is also an important component of an urban landscape. Open space can be provided by the recreational parks described above. It can also be provided for by the residential building process, i.e. by requiring builders to build their new communities following the clustering principle.

Preservation of unique land areas should also be considered when regulating the urban development process. It may be desirable to preserve prime agricultural land - land which could be used, for instance, to produce fresh fruits and vegetables for the nearby urban population.

The control of the urban development process is probably the single most important problem facing most cities and towns in the Basin. Success in controlling this process will have a major impact on the needs which the upstream watershed projects can satisfy, such as flood protection, municipal and industrial water supply, and recreational facilities.

Food and Fiber Production

Food and fiber production in the Basin should not be given priority for utilization of scarce resources. Given the transportation situation in the United States, it is economically feasible for the more intensive agricultural areas such as the Midwest to supply the less intensive agricultural areas such as the East. Therefore, to give high priority to use of resources in the Basin for agricultural production simply to maintain the Basin's historical share of production, may not be the most efficient use of the resources.

The Basin can maintain its historical share of food and fiber production without disruption of the resource base for higher priority needs. It has been estimated that 250 to 300 thousand additional acres (Table III-24) of agricultural land will be needed by 2020 to maintain the Basin's historical share of production. There are presently (1967) 2,097,100 acres (Table II-3) of forest land in land capability classes I thru IV, most of which could probably be converted to agricultural production if needed. This would only be partially offset by the 302,600 acres of agricultural land in land capability classes V thru VIII which may change to forest land. A more detailed analysis of the location of the prime forest land would be useful to determine its availability for conversion. However, this is probably not necessary since the combined effect of the change of agricultural land is only one-third of the amount of prime forest land. Development of the twelve early action watersheds would create a need for only 5,000 additional retarding structures.

Water Supply

The amount and distribution of rainfall is generally adequate for the crops grown in the Basin. Therefore, the development of sources of water for irrigation purposes is not of great importance. There is, however, some irrigation of truck crops around the urbanized areas which may be desirable to maintain. Maintenance of irrigation practices on other high value crops may also be desirable.

Water supply sources for rural domestic and agricultural use are adequate. Consideration for project development should not be given for provision of additional supply for these purposes.

Additional flow requirements will be needed in the James River for industrial purposes in the Covington, Clifton Forge, and Richmond areas, and Alleghany, Chesterfield, Henrico

and Hanover Counties. This need is becoming acute and priority should be given to the provision of additional supplies of industrial water for these areas especially during low-flow periods.

Supplemental flow to maintain municipal water supply withdrawals may be required by 1980 in the Covington, Lynchburg, and Maury River areas. This is also a priority item. The Gathright Dam project will satisfy some of these needs and should be considered when evaluating the need for additional supplies.

Recreational Development

Role of Local Government

For the most part, units of local government are responsible for developing action recreation programs at the local level. In many instances, however, there are obvious shortcomings with regard to knowing in precise terms what the recreation needs are and how these needs may be met. In this regard, local government entities should assume more of the responsibility for recreation planning and the obligation for meeting recreation demand within their respective communities. One of the foremost needs of the Basin has been shown to be a lack of recreation facilities in lands close to where most people live.

Role of the Private Sector

In high density use areas, private enterprise has the opportunity of providing capital, management, and labor for recreation services and facilities. Such services and facilities may include swimming pools, riding stables, boat marinas, etc., available to the public on a fee basis.

Under certain conditions, optimum recreation benefits for a recreation resource such as an impoundment or stream would accrue if recreation facilities are both owned and operated by the private sector. In other situations, some of the facilities might be publicly owned but maintained and operated privately under a lease or concession system. In some instances, public ownership is essential because of economics, public health, and safety, etc. In general, public facilities tend toward the rustic and provide those services which meet basic recreation demands. Private enterprise can complement these facilities by providing additional opportunities and services demanded by the public. Through cooperative efforts, a larger segment of the population can be satisfied, especially in rural areas.

Preservation of the Natural and Scenic Resources

The Land Use Task Force of the Governor's Council on the Environment recently issued a report which included the following statement:

> The coastal zone and estuaries, flood plains, shorelines, and other lands near or under major bodies of water which possess special natural and scenic characteristics are being damaged and threatened by unrestricted development.

The Task Force recommended that legislation be enacted establishing a land use policy with guidelines for Statewide land use planning and which assigns responsibilities and priorities for the implementation of policy and guidelines. Without a land use policy, certain land areas and uses are of immediate and special concern. These critical areas include the coastal wetlands, unique natural areas, unspoiled wilderness, unique habitats, and irreplaceable scenery all part of Virginia's heritage. The Task Force chairman commented that "a decisive commitment to a State land use policy is needed now."

In this report, many of the Basin's streams and rivers have been identified for inclusion into a Statewide Scenic Rivers System. Not only do these streams offer substantial recreation potential, their preservation or restoration is vital to maintaining a quality living environment for man as well as other desirable life forms.

Recreation Alternatives Outside the Basin

A number of regional, State, and Federally administered areas and parks within Virginia and in adjacent States serve the residents of the James River Basin. In Virginia, major areas include extensions of the George Washington and Jefferson National Forests as well as the Blue Ridge Parkway. The Shenandoah National Park and the Skyline Drive are important recreation oriented areas extending north of the Basin from the Blue Ridge Parkway. A major water oriented recreation area within the State is the Corps of Engineers 53,180-acre Kerr Reservoir and the 20,300-acre Lake Gaston hydroelectric reservoir located about 80 miles south of Richmond along the Virginia and North Carolina State line. Other important water recreation areas within the State include the Chesapeake Bay, Potomac, Rappahannock, and York estuaries.

Supporting Programs

There is no single solution that will relieve the need for recreation water during the summer season. All measures that might make more water and other facilities available should, however, be explored. A number of measures are available to support and strengthen the carrying capacity of existing and new facilities. These measures include both physical measures and regulatory practices which, if applied vigorously to protect and improve water quality, would increase the efficiency and usefulness of water resources. Such measures should be established by the proper governmental entity where they are feasible and they should be administered unequivocally to prevent development which would impair the aesthetic and recreational values of streams and lakes.

The effectiveness of any recreation plan is directly tied into the quality of water available for use. Any area of water lost through pollution reduces the supply by that amount and increases the pressures for use on already deficient supplies of recreational facilities. Water cannot be considered available for recreation use unless it is of suitable quality. Minimum quality standards permit partial body contact, but the goal should be a quality of water that will permit whole body contact. There are two independent qualities which must be assumed in recreation waters - the absence of health hazards and desirable aesthetic qualities.

Pollution can affect recreation activites in several ways. Swimmers and water skiers coming into direct contact with the water are subject to illnesses caused by sediments, or algal growth increases risks to swimmers by reducing visibility under water. Contact with or ingestion of chemical wastes, pesticides, and similar products can cause serious injury to swimmers and others in such waters. A boater's major concern is physical damage to equipment by extreme acidity, alkalinity, floating debris, or chemical wastes.

All water dependent and water enhanced activites are adversely affected by: visible floating, suspended or settled solids, arising from the disposal of garbage, sludge banks, slime infestation, heavy growths of attached plants or animals, blooms of high concentrations of plankton, discoloration or excessive turbidity from sewage, industrial wastes, or even natural sources; the evolution of dissolved gases, especially hydrogen sulphide; visible oil or grease, including emulsions, excessive acidity or alkalinity that leads to delignification of boats and docks; surfactants that form when water is agitated or aerated; and excessive temperatures that cause high evaporation and

cloudiness over the water.

Recreation is adversely affected by all improperly treated municipal and industrial wastes. Waters returned to streams or lakes from sewage treatment plants usually contain pathogenic organisms and/or polluting materials. In addition, waste water commonly has offensive odors, tastes, or turbidity, which limits its aesthetic value as well as its direct use. Solid wastes are often discarded or stored in places where they can degrade water.

Agriculture is responsible for several types of pollutants such as sediments resulting from soil erosion, residues from pesticides, and the leaching of nutrients from animal wastes and solids. Sedimentation commonly reduces the quality of water both physically and chemically. Land is often put to those uses for which it is not well adapted; frequently, land and water conservation practices are not adequately and properly applied. As a result, silt pollution of streams and reservoirs is a major problem in the James River Basin. It is estimated[1/] that about 60 percent of the Basin's agriculture lands need application of soil conservation practices to minimize pollution attributed to agriculture and poor land treatment and management practices.

The construction industry permits substantial quantities of soil sediments to enter water courses near construction areas. They make little effort to apply proven control measures to reduce this source of sediments to a minimum. They have often failed to cooperate in evolving new techniques to control this source of pollutants more effectively.

Scale of Development

The scale of development expressed for existing water resources within this report should be viewed as preliminary, subject to substantial refinement as these resources are studied individually in more detail. Initial development of potential scenic rivers represents one-third of the ultimate estimated carrying capacity for each category of the river. For streams and rivers not included as potential scenic rivers, initial recreation development is considered as ultimate.

For multiple-purpose impoundments of small watersheds initial recreation development is considered as ultimate.

1/ Soil Conservation Service, Richmond, Virginia.

Schedule of Development

Development priorities for the various subareas are based upon unsatisfied recreation demands for water dependent and water enhanced recreation activities as well as the preservation of the Basin's natural streams and rivers. In this regard, emphasis must be given to the utilization of the Basin's existing streams and rivers, impounded waters, and to the development of newly impounded water near where most people live.

APPENDIX A

The Land Capability Classification

The land capability classification is a grouping of soils made primarily for agricultural purposes. This classification scheme begins with the individual soil-mapping unit as the building stones of the system.

The capability grouping of soils is designed to (1) help landowners and others use and interpret the soil maps, (2) introduce users to the details of the soil map itself, and (3) make possible broad generalizations based on soil potentialities, limitations in use, and managment problems.

The capability class is the broad grouping of soils based on the risk of soil damage or limitations in use (indicated by I through VIII). The risks of soil damage or limitations in use become progressively greater from class I to class VIII. Soils in classes I through IV are capable under good managment of producing adapted plants - common cultivated crops, pasture plants, and forest trees. Soils in classes V through VII should not normally be used for cultivated annual or short-lived crops, but can be used for orchards, pasture, forest trees, or wildlife. Soils in class VIII have practically no agricultural use. Included are such areas as rock outcrops, swamps, marshes, and coastal beaches.

The capability subclass is a grouping of capability units having similar kinds of limitations or hazards. In Virginia, three kinds of limitations or hazards are recognized: (1) erosion, (2) wetness, and (3) unfavorable soil conditions (indicated by the letters "e", "w" and "s" respectively).

Class I soils are those that have the widest range of use and the least risk of damage. They are level or nearly level, well drained, productive, and easy to work. They can be cultivated intensively with practically no risk of erosion and will remain productive if managed with normal care. (Obviously, since soils in this class have no limitations, it is the only class without subclasses.)

Class II soils have some limitations that reduce the choice of plants or require moderate conservation practices. The limitations are few and practices are easy to apply. These soils may be used for cultivated crops, pasture, orchard, forest land, or for wildlife food and cover.

Class III soils have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Limitations may restrict the amount of clean cultivation; time of planting, tillage, and harvesting; choice of crops; or a combination of these items. They may also be used for pasture, orchards, forest land, or wildlife food and cover.

Class IV soils have very severe limitations that restrict the choice of cultivated crops and require very careful management or both. When these soils are cultivated conservation practices are difficult to apply and maintain. This is a marginal class for cultivated crops but is generally well suited for pasture, orchards, forest land, or wildlife food and cover.

Class V soils have little or no erosion problems but have other limitations that are impractical to remove, which limit their use largely to pasture, forest land, or wildlife food and cover. (There is little of this kind of land in Virginia.)

Class VI soils have limitations that make them unsuited for cultivations and limit their use primarily to pasture, forest land, or wildlife food and cover. Relative productivity of soils in this class vary widely depending upon individual soil features. Some soils in this class may be used for special crops, such as sodded orchards.

Class VII soils have limitations that make them unsuited for cultivation and restrict their safe use largely to managed grazing, forest land, and wildlife food and cover. It is generally impractical to apply pasture improvements such as seeding, liming, and fertilizing, and most soils in this class have low potential for timber production.

Class VIII soils and landforms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, water supply, or aesthetic purposes.

Soil Associations

One or more major soils and at least one minor soil are generally grouped together as a soil association. A soil association is a landscape that has a distinctive proportional pattern of soils. It is usually named for the major soils in its group. The soils in one association may occur in another, but in a different pattern.

Following are brief descriptions of the soil associations delineated on the General Soil Map, Figure 6 in the main body of this report.

Soil Association Group 1

Dekalb, Weikert, Hayter, Jefferson. This assocation is characterized by shallow to deep soils formed in the weathered products of sandstone and shale. The drainage patterns are well defined.

The Delkalb soils have brown to yellowish brown fine sandy loam and stony fine sandy loam surface layers and brownish yellow fine sandy loam subsoils. The Weikert soils have grayish brown silt loam subsoils where they are present. Hayter soils have brown loam surface soils and strong brown fine sandy clay loam to clay loam subsoils. The Jefferson soils have brown fine sandy loam surface soils and yellowish brown fine sandy clay loam subsoils. Inclusion of soils similar to Jefferson with gragipan 30 inches or more below the surface are common. Other inclusions are limestone soils that range from deep to shallow with silt loam surfaces and clay subsoils and colluvial and alluvial soils that range from well to poorly drained.

Soil Association 2

Frederick, Hagerstown, Berks. This association is characterized by deep to moderately deep soils formed in the weathered products of limestone and shales with minor inclusions of sandstone. The drainage patterns are not well defined due to sinks in the drainage ways. The Frederick soils have brownish yellow silt loam surface layers and yellowish red to red clay subsoils. The Hagerstown soils have reddish brown silt loam surface layers and reddish brown to red silty clay loam to clay subsoils. The Berks soils have yellowish brown silt loam surface layers and brownish yellow silt loam to silty clay loam B horizons. There are minor inclusions of colluvial and alluvial soils that are well to poorly drained.

Porters-Chester-Clifton-Famsey Association. This association is characterized by moderately deep to very shallow, well drained to excessively well drained soils on the Blue Ridge Mountains. The topography is mostly steep to very steep, with some sloping and moderately steep relief on the mountaintops and in the hollows. Parent material includes granite, granodiorite, greenstone, and quartzite. The drainage patterns are well defined. Most of the surface soils are brown stony loams or stony silt loams. Subsoils, where present, are brown to reddish brown light clay loams. Most of these soils are stony types. There are many areas of stony land and rocky land. There are minor areas of Tusquitee soils and stony colluvium in the hollows.

Cecil-Appling-Louisburg. This association is characterized by deep and shallow well drained soils formed mainly from the weathered products of granites, gneisses and schists. The Cecil and Appling soils are on gently sloping to sloping relief. These are deep, well drained soils. The shallow Louisburg soils are mostly on strongly sloping to moderately steep relief. Drainage patterns are well defined

within the area. The Cecil soils have yellowish-brown fine sandy loam surface layers and red clay subsoils. The Appling soils have yellowish-brown surface layers and yellowish-red clay subsoils. Louisburg soils are shallow and have grayish-brown sandy loam surface layers and thin yellowish-brown sandy loam to sandy clay subsoils. There are minor areas of soils such as Lloyd, Vance, Mecklenburg and Enon; Madison, Wilkes, Iredell, Helena, Worsham, Wehadkee, Congaree and Chewacla.

Davidson-Starr Association. This association is dominated by the deep well drained Davidson soils formed from the weathered products of greenstone. They are on gently sloping to steep relief. The drainage patterns are well defined. The Davidson soils have dark reddish brown clay loam surface layers and dark red clay subsoils. The Starr soils are colluvial soils with dark reddish brown loam surface soils and red clay loam subsoils. Included on the mountains are areas of stony Davidson and stony land.

Tatum-Nason. This association is characterized by deep well drained soils formed in the weathered products of sericity schist. Most of the area is on gently sloping to sloping relief. The drainage patterns are well defined. The Tatum soils have yellowish brown loam surface layers and red clay subsoils. The Nason soils have yellowish-brown loam surface layers and yellowish-red clay subsoils. There are minor areas of shallow Manteo and Goldston soils, well drained Georgeville and Herndon soils, moderately well drained York and Lignum soils and alluvial soils including Worsham, Chewacla and Wehadkee.

Creedmoor-Mayodan. This association is characterized by deep to moderately deep, well to moderately well drained soils formed in the weathered products of Triassic sandstone and shale. The moderately deep, moderately well drained Creedmoor soils are mostly on gently sloping relief; the deep, well drained Mayodan soils are mostly on gently sloping to sloping relief. The drainage patterns are moderately well defined. The Creedmoor soils have grayish-brown fine sandy loam surface layers and yellowish-brown plastic clay subsoils. The Mayodan soils have yellowish-brown fine sandy loam surface layers and yellowish-red heavy clay loam subsoil. There are minor areas of well drained Wadesboro soils, moderately well drained White Store soil and excessively drained Pinkston soils.

Sassafras-Kempsville Association. This association is characterized by deep, well-drained nearly level to gently sloping medium textured soils on Coastal Plain ridges. The Sassafras soils have brown fine sandy loam surface layers and strong brown fine sandy clay loam subsoils. The Kempsville soils have grayish brown fine

sandy loam surface layer and yellowish brown fine sandy clay loam subsoils. The subsoils may have a slightly compact layer which may restrict the movement of water and roots slightly. There are minor areas of excessively drained loamy and gravelly sediments on steep slopes, moderately well-drained Woodstown soils, well-drained Caroline soils, and poorly drained mixed alluvial land in the flood plains.

Hiwassee-Wickham-Altavista-Congaree Association. This association is characterized by deep well and moderately well-drained, nearly level to gently sloping stream terrace and bottom soils. The Hiwassee soils have brown fine sandy loam surface layers and sticky, red, heavy clay loam and silty clay loam subsoils. The Wickham soils have brown fine sandy loam surface layers, strong brown and yellowish red fine sandy clay loam and clay loam subsoils. The Altavista soils have grayish brown fine sandy loam surface layers and yellowish brown mottled gray heavy clay loam subsoils. The Congaree soils occur on the first bottom and have brown fine sandy loam surface layers and strong brown loam and light fine sandy clay loam subsoils. There are minor areas of somewhat poorly drained Augusta soils, poorly drained Roanoke soils, and moderately well and somewhat poorly drained Chewacla soils on the flood plain.

Norfolk-Chesterfield-Marlboro-Caroline Association. This association is characterized by deep, well-drained nearly level to gently sloping fine textured soils on Coastal Plain ridges. The Norfolk soils have grayish brown fine sandy loam surface layers and yellowish brown fine sandy clay loam subsoil. The Chesterfield soils have grayish brown fine sandy loam surface layers of transported material and yellowish brown to yellowish red clay subsoils derived from residual granitic rock. The Marlboro soils have grayish brown very fine sandy loam surface layers and yellowish brown and strong brown heavy clay loam subsoils. The Caroline soils have grayish brown very fine snady loam surface layers and strong brown and yellowish red, clay subsoils. There are minor areas of moderately well-drained Atlee soils, somewhat poorly drained Dunbar and Lenoir soils, and poorly drained Bladen soils.

Bertie-Dunbar-Woodstown Association. This association is characterized by deep, moderately well-drained to somewhat poorly drained nearly level to gently sloping soils in the Coastal Plain. The Bertie and Dunbar soils have yellow fine sandy loam surfaces and yellow mottled with light gray fine sandy clay loam and clay subsoils. The Woodstown soils have yellowish brown friable, fine sandy loam surface soils and brownish yellow fine sandy clay loam to sandy clay loam subsoils mottled at 18 to 20 inches with yellow, strong brown and gray. There are minor areas of well-drained Norfolk and poorly drained Othello. There is also a narrow area in the extreme eastern portion of Nansemond County in the Dismal Swamp consisting of poorly drained soils and much peat. There are also some very narrow steep areas around natural drainageways consisting of loamy and gravelly sediments.

Culpeper-Albermarle-Louisburg. This association is characterized by deep well-drained soils formed in the weathered products of sandstone, shale, and mica schist. Most of the area is on gently sloping to moderately steep relief. The drainage patterns are well defined. The Culpeper soils have yellowish brown loam to fine sandy loam surface layers and red clay subsoils. The Albermarle soils have yellowish brown fine sandy loam surface layers and yellowish red clay loam subsoils. The Louisburg soils are shallow and have grayish brown sandy loam surface layers and thin yellowish brown sandy loam to sandy clay subsoils. Also included in this association are areas of micaceous Elioak soils, moderately well drained Colfax soils, and poorly drained Worsham soils.

Physiography and Geology

The James River Basin lies within parts of four physiographic provinces (Figure 2 and Figure 3). These are the Ridges and Valleys, Blue Ridge, Piedmont and Coastal Plain. The James River has its origin in the Ridges and Valleys which is underlain by sedimentary rocks ranging from sandstone to limestone then it flows through a narrow belt of the Blue Ridge which are mainly igneous and metamorphic rocks. The James River then enters into a wide belt of the Piedmont underlain by metamorphic and igneous rocks with minor amounts of sedimentary rocks. The James River leaves the Piedmont at the fall line near Richmond and flows the rest of the way to the Atlantic Ocean through the Coastal Plain. The Coastal Plain is underlain by marine sediments of varying composition and hardness ranging from sandstone to clay and marl. The following paragraphs give a more detailed description.

The Ridges and Valleys province, in the westernmost part of the Basin, is a mountainous region of folded and thrust-faulted sedimentary rocks which range in age from Cambrian to Mississippian. Pennsylvania-age rocks lie in parts of this province outside the Basin. There are a few isolated igneous stock (mainly lamprophyre) in Highland County. The axes of the fold trend generally N 45^{o} E. Within the Basin, the eastern two-fifths of the province is a synclinal carbonate belt, with some basal quartzites on the east edge. This belt is thrust north-westward over principally clastic rocks - shales and sandstone. The westernmost edge of the Basin is essentially an anticlinorium in the core of which carbonates, and the lamprophyre stocks are exposed.

The topography is made up of linear, northeast-treading ridges and valleys, a result of differential erosion upon the regional structure. Notable ridge-forming rock units are the Price-Pocono sandstone (Mississippian), Oriskany sandstone (Devonian), and the

Tuscarora quartzite (Silurian). Extensive talus deposits derive from these formations, but soils developed upon them tend to be thin, coarse-grained, generally brown sands. The Braillier and Marlboro shales of Devonian age are the principal shale units. They form brown or tan clay-silt soils. Carbonate include the Helderberg limestone (Devonian); the Stones River Group, Beekmantown linestone and Conococheague limestone (Ordovician); the Elbrook Dolomite (Cambrian); and others. Caverns are a major problem in these units. Soils developed on these rocks are variable in thickness, usually consisting of red clay-silt mixtures. Alluvial soils vary from gravelly and sandy in regions of clastic rocks to clayey and silty in limestone areas. The stream pattern in the Ridges and Valleys province is of the trellis type.

The Blue Ridge province within the Basin is a relatively narrow, mountainous belt underlain by the Catoctin greenstone and various granites and granodiorites which intrude it. These rocks are probably Precambrian in age. Quartz, biotite, amphibole, epidote, plagioclase, orthoclase and chlorite are mintrals commonly occurring here. These rocks are thrust northwesterly over the eastern edge of the Ridges and Valleys province, overturning the units there.

Talus is common on mountain sides in this region; soils tend to be thin, and sandy or gravelly. Alluvial materials tend to be very coarse, in many cases consisting of large boulders. The stream pattern is dendritic.

The Piedmont province occupies the largest portion of the Basin. It is underlain chiefly by gneisses and schists, with some marble, and granites and granodiorites which intrude the metamorphic rocks. The rocks are complexly folded, the foliation striking generally N 45° E. Principal units include the Catoctin greenstone, Lovingston granite gneiss, Lynchburg schist, and others, all Precambrian except the Arvonia slate, which is Ordovician. Several downfaulted basins within the Piedmont province contain Triassic sandstones and shales derived from the older rocks, and diabase silts, produced by volcanic disturbances in the Triassic period. These units dip gently westward toward normal faults bounding the basins on the west.

The residual soils of the schists and Triassic shales tend toward clays and silts; those soils on both schist and gneiss grade from clay at the surface to coarse sand in the parent material. Alluvial soils in the Piedmont province are mainly sands and silts with some gravel (more notably near the Blue Ridge Mountains), and sometimes clay, quartz, mucovite, biotite, orthoclase, plagioclase, amphibiles, epiodote, kyanite and other minerals are present in the Piedmont rocks.

The topography in the Piedmont province ranges from mountainous near the Blue Ridge Mountains to very gently rolling at the edge of the Coastal Plain province. The stream pattern is principally dendritic, although there is some structural control, such as in certain Triassic basins and in fault zones as along the James River northeast of Lynchburg.

The Coastal Plain province consists of hard sandstones and clay and less indurated sands, gravels, and clays, all marine which rest unconformably upon the crystalline rocks of the Piedmont province. These sediments range in age from Cretaceous to Quarternary and dip gently eastward. The province makes up less than one-sixth of the Basin. Residual soils may be silts, clays, or sands, with various mixtures of these. Alluvial soils consist largely of sands, with silt, clay, and gravel layers. The nearly level topography is undergoing dissection by streams forming a dendritic pattern. The James River here is a tidal estuary or drowned valley.

Appendix A. Table 1. Outstanding storage potential sites, James River Basin

Physiographic Province CNI Watershed Number and County	Site Number	Stream Name	Drainage Area (Sq. Mi.)	Storage: Flood Prevention 1/ (Ac. Ft.)	Storage: Beneficial 2/ (Ac. Ft.)	Surface Area 3/ (Acres)
Ridges and Valleys						
VA-12-6 Highland	1G 4/	Jackson River	43.0	9,160	23,000	640
12-10 Alleghany	6 4/	Mill Branch	7.3	1,670	3,900	130
12-11 Monroe, W.Va.	1A 4/	Potts Creek	30.5	6,660	4,700	450
12-12 Highland	1B 4/	Bullpasture River	71.2	10,800	31,300	1280
12-22 Botetourt	7 4/	Borden Creek	5.3	1,400	2,800	160
12a-1 Augusta	1 4/	Calfpasture River	11.6	2,530	6,200	250
12a-2 Rockbridge	2	Little Calfpasture River	54.8	11,810	38,000	1180
12a-3 Rockbridge	6B	Hays Creek	48.3	13,450	33,500	1440
12a-5 Rockbridge	11B	Buffalo Creek	52.7	14,620	36,500	1060
Blue Ridge & Piedmont						
VA-12-23 Nelson	2 4/	Perry Creek	7.0	2,280	3,700	260
12-23 Nelson	3 4/	Taylor Creek	7.1	2,290	3,800	200
12-24 Nelson	1 4/	So. Fork Rockfish River	34.6	10,500	17,400	840
12-25 Nelson	4 4/	Hat Creek	11.5	3,540	6,100	300
12-26 Amherst	3 4/	Indian Creek	7.3	2,270	3,900	200
12-30 Albemarle	2A 4/	Middle Branch	6.2	2,050	3,300	260
12-30 Albemarle	4 4/	So. Fork Hardware River	11.6	3,820	6,200	420
12-31 Albemarle	1A	Rucker Run	25.4	6,910	17,100	810
12-33 Bedford	1A	Ivy Creek	24.0	7,040	16,100	860
12-34 Albemarle	4A	Totier Creek	28.0	7,760	18,800	1420
12-35 Buckingham	1C	David Creek	41.1	11,400	27,600	1750
12-41 Appomattox	1A 4/	Bent Creek	10.3	2,860	5,500	350
12-42 Appomattox	1A	Wreck Island Creek	18.5	5,130	12,400	630
12-42 Appomattox	3 4/	North Creek	12.3	3,390	6,600	450
12-43 Campbell	4	Beaver Creek	20.7	5,740	13,900	640
12-44 Fluvanna	3 4/	Little Byrd Creek	12.9	3,240	6,900	440
12-44 Goochland	8	Little Byrd Creek	11.9	2,980	7,700	620
12-46 Goochland	1B	Lickinghole Creek	31.5	7,900	20,500	1560
12-46 Goochland	2A	Little Lickinghole Creek	27.0	6,770	17,600	1240
12-48 Powhatan	1	Muddy Creek	15.7	3,930	9,800	780
12-49 Cumberland	1A	Deep Creek	26.8	6,720	16,700	1180
12-50 Goochland	1A 4/	Beaverdam Creek	16.4	4,080	8,800	810
12-66 Campbell	7	Blackwater Creek	19.2	5,630	12,900	680
12-28 Amherst	7	Horsely Branch	8.0	2,430	5,380	280
12b-3 Albemarle	5C	Ivy Creek	24.7	8,300	16,600	1020
12b-4 Albemarle	1C	Moormans River	31.8	10,680	21,400	1280
12b-6 Albemarle	1B	Mechum River	34.5	11,590	23,200	1150
12b-6 Albemarle	4B 4/	Stockton Fork	21.5	7,580	11,500	580
12b-8 Albemarle	4A	Biscuit Run	12.4	4,360	8,300	560

See footnotes at end of table.

Appendix A. Table 1. Outstanding storage potential sites, James River Basin--Continued

Physiographic Province CNI Watershed Number and County	Site Number	Stream Name	Drainage Area (Sq. Mi.)	Storage: Flood Prevention 1/ (Ac. Ft.)	Storage: Beneficial 2/ (Ac. Ft.)	Surface Area 3/ (Acres)
Blue Ridge & Piedmont (Cont.)						
VA-12b-10 Albemarle	8A	Buck Island Creek	31.0	10,080	20,800	1560
12b-11 Fluvanna	7B	Cunningham Creek	31.1	10,120	20,900	1250
12b-11 Fluvanna	8	Ballinger Creek	17.2	5,590	11,600	590
12c-1 Appomattox	4A 4/	Appomattox River	46.2	11,440	24,600	1210
12c-3 Amelia	7	Sandy Creek	8.6	2,110	5,400	480
12c-3 Cumberland	11B 4/	Big Guinea Creek	29.8	7,240	15,900	1320
12c-4 Prince Edward	1C 4/	Bush River	59.0	14,100	31,500	2200
12c-4 Prince Edward	4B	Briery Creek	36.5	8,960	22,800	1460
12c-4 Prince Edward	5B 4/	Sandy River	36.2	8,760	19,300	1390
12c-5 Powhatan	1A	Fighting Creek	23.4	5,740	13,500	1570
12c-5 Powhatan Chesterfield	4	Skinquarter Creek	11.5	2,820	6,500	700
12c-6 Amelia	1C	Flat Creek	75.0	18,000	43,200	1540
12c-6 Amelia	6	Nibbs Creek	14.4	3,460	8,300	480
12c-8 Chesterfield	3	Winterpock Creek	20.2	4,950	11,600	1090
12c-9 Nottoway	1B 4/	Deep Creek	43.4	10,360	23,200	2060
12c-9 Nottoway	3	Woody Creek	13.3	3,190	7,700	690
12c-9 Amelia	8	West Creek	15.5	3,720	8,900	710
12c-10 Amelia & Dinwiddie	1	Namozine Creek	18.9	4,540	10,900	970
Coastal Plain						
12-53 Henrico	1	Chickahominy River	15.1	3,700	10,100	1120
12-55 Chesterfield	1A	Falling Creek	16.8	4,120	10,500	860
12-64 Isle of Wight	2	Champion Swamp	12.2	2,990	6,400	750
12c-7 Chesterfield	5	Second Branch	12.7	3,650	7,300	800
12c-11 Dinwiddie	1	Whipponock	9.9	2,380	5,700	600

1/ Includes Sediment & Flood Detention Storage

2/ Beneficial Storage based on same criteria used in Table VIII-30.

3/ Surface area at crest of emergency spillway.

4/ These sites are included in Watershed Investigation Reports for potentially feasible PL-566 projects.

Appendix A. Table 2. Flood plain land use and average annual floodwater damages, 1968, James River Basin

W/S #	Flood plain Land Use Ac. Crop & Pasture	Woodland	Urban & Other	Total	Floodwater Damages (Dollars) Crops & Pasture	Other Agric.	Urban & Commercial	Trans. Facil.	Total
12-1 1/	2,000	1,000	15	3,015	2,800	1,000	28,200	13,000	45,000
12-2									
12-3	350	150	75	575	200	–	39,900	4,100	44,200
12-4	1,050	100	360	1,510	4,100	1,700	48,100	5,000	58,900
12-5	750	150	–	900	100	–	–	1,000	1,100
12-6	2,790	340	270	3,400	4,800	1,600	54,300	7,300	68,000
12-7	2,050	250	200	2,500	2,600	900	30,000	4,000	37,500
12-8	1,350	1,400	150	2,900	100	–	12,800	–	12,900
12-9	350	100	50	500	450	50	9,000	2,000	11,500
12-10	790	250	80	1,120	1,200	100	22,000	2,000	25,300
12-11	660	150	20	830	2,850	1,440	8,000	6,800	19,000
12-12	4,500	240	550	5,290	13,200	600	52,400	12,900	79,100
12-13	1,600	80	190	1,870	4,500	200	19,000	4,400	28,100
12-14	12,640	730	1,500	14,870	29,000	9,700	125,700	29,000	193,400
12-15	140	420	120	680	–	–	51,700	3,300	54,400
12-16	1,280	120	20	1,420	6,000	200	2,000	800	9,000
12-17	1,580	150	70	1,800	9,000	3,400	11,000	12,400	36,000
12-18	1,040	150	150	1,340	15,300	–	5,200	3,400	23,900
12-19	1,590	100	90	1,780	9,500	3,300	10,600	11,600	35,000
12-20	–	210	420	630	–	–	8,000	2,500	10,500
12-21	700	100	20	820	1,500	100	1,000	–	2,600
12-22	1,690	260	50	2,000	4,900	1,900	13,300	5,900	26,000
12-23	1,050	120	40	1,210	4,500	2,000	7,300	10,700	24,500
12-24	2,900	300	130	3,330	9,000	3,200	12,000	15,800	40,000
12-25	2,420	390	170	2,980	8,000	2,600	17,500	7,800	35,900
12-26	1,360	190	330	1,880	2,200	800	39,700	6,200	48,900
12-27	1,520	420	270	2,210	15,000	3,100	1,900	1,900	22,300
12-28	850	450	50	1,350	2,600	900	7,600	5,000	16,100
12-29	60	550	460	1,070	–	–	500	–	500
12-30	4,640	660	150	5,450	26,300	9,100	–	13,600	49,000
12-31	300	1,110	–	1,410	100	–	–	900	1,000
12-32	250	460	60	770	500	200	–	4,200	4,900
12-33	510	520	1,180	700	700	1,200	19,900	2,700	24,500
12-34	3,510	1,000	630	5,140	1,200	100	–	270	1,570
12-35	690	3,660	230	4,580	2,200	200	–	190	2,590
12-36	2,030	630	460	3,120	600	100	12,000	2,000	14,700
12-37	1,470	5,010	590	7,070	500	–	–	–	500
12-38	250	280	20	550	2,100	100	300	200	2,700
12-39	240	40	30	310	5,400	200	400	1,500	7,500
12-40	980	1,430	100	2,510	34,000	500	4,000	3,300	41,800
12-41	420	290	30	740	900	400	–	900	2,200
12-42	910	390	–	1,300	4,300	1,400	–	9,900	15,600
12-43	320	50	150	520	1,000	300	1,200	3,500	6,000
12-44	2,200	4,060	–	6,260	6,200	3,200	–	6,200	15,600
12-45	1,350	5,040	1,140	7,530	30,500	–	2,600	6,600	39,700
12-46	2,740	5,560	200	8,500	1,600	500	–	900	3,000
12-47	10,000	1,000	30	11,080	400	–	–	100	500
12-49	290	2,000	–	2,290	1,100	300	–	3,100	4,500
12-50	670	430	–	1,100	3,600	400	1,300	2,400	7,700
12-51	7,820	1,000	30	8,850	800	–	–	100	900
12-52	330	2,700	350	3,380	100	–	6,000	300	6,400
12-53	–	2,600	200	2,800	–	–	6,400	2,000	8,400
12-54	–	290	800	1,090	–	–	5,000	5,000	10,000
12-55	–	230	20	250	–	–	500	200	700
12-56	–	8,500	500	9,000	–	–	13,000	4,000	17,000
12-57	–	3,450	–	3,450	–	–	–	–	–
12-58	–	50	–	50	–	–	–	200	200
12-59	–	–	–	–	–	–	–	–	–
12-60	–	120	–	120	–	–	–	–	–
12-61	–	–	–	–	–	–	–	–	–

See footnotes at end of table.

Appendix A. Table 2. Flood plain land use and average annual floodwater damages, 1968, James River Basin--Continued

W/S #	Flood plain Land Use Ac.				Floodwater Damages (Dollars)				
	Crop & Pasture	Woodland	Urban & Other	Total	Crops & Pasture	Other Agric.	Urban & Commercial	Trans. Facil.	Total
12-62	-	-	-	-	-	-	-	-	-
12-63	-	200	300	500	-	-	-	-	-
12-64	-	-	-	-	-	-	-	-	-
12-65	200	1,140	-	1,340	1,000	500	-	500	2,000'
12-66	-	260	110	370	-	-	1,000	400	1,400
12-67	140	20	20	180	1,900	1,000	2,100	-	5,000
12a-1	4,000	1,100	400	5,500	8,100	3,000	45,700	26,100	82,900
12a-2	740	650	1,110	2,500	200	200	20,900	3,700	25,000
12a-3	1,530	20	60	1,610	3,200	1,200	23,700	20,200	48,300
12a-4	1,050	450	20	1,520	1,500	3,500	3,600	1,900	10,500
12a-5	1,600	130	50	1,780	2,800	18,100	70,300	7,000	98,200
12a-6	1,300	600	620	2,520	1,500	700	44,300	20,700	67,200
12b-1	950	450	30	1,430	10,000	3,400	-	15,100	28,500
12b-2	850	350	20	1,220	8,400	4,000	-	12,000	24,400
12b-3	630	270	10	910	8,100	2,800	-	-	10,900
12b-4	800	340	30	1,170	4,200	1,400	-	8,200	13,800
12b-5	130	10	-	140	2,600	900	2,500	600	6,600
12b-6	2,700	150	150	3,000	14,700	5,000	-	16,100	35,800
12b-7	550	550	30	1,130	1,400	500	-	20,700	22,500
12b-8	600	520	200	1,320	1,500	400	15,000	5,500	22,400
12b-9	1,690	1,100	30	2,820	14,600	400	-	1,300	16,300
12b-10	1,700	1,700	70	3,470	21,400	4,000	-	23,100	48,500
12b-11	4,000	3,500	60	7,560	63,100	3,700	-	31,400	98,200
12b-12	820	550	80	1,450	12,400	4,400	-	12,200	29,000
12b-13	480	210	20	710	5,300	2,000	-	500	7,800
12b-14	180	130	40	350	7,500	1,000	1,000	8,000	17,500
12c-1	2,450	2,940	60	5,450	10,200	3,200	2,100	2,000	17,500
12c-2	3,650	3,830	180	7,660	32,000	-	-	37,900	69,900
12c-3	2,980	4,680	850	8,510	12,400	-	3,100	1,500	17,000
12c-4	350	2,770	340	3,460	2,500	-	1,100	4,200	7,800
12c-5	230	2,550	60	2,840	1,900	-	700	3,200	5,800
12c-6	190	2,110	50	2,350	1,800	700	-	3,300	5,800
12c-7	30	1,850	180	2,060	200	100	2,200	5,700	8,200
12c-8	360	8,060	540	8,960	2,100	800	-	3,800	6,700
12c-9	480	5,310	120	5,910	4,700	1,800	-	8,200	14,700
12c-10	50	1,080	-	1,130	200	-	-	300	500
12c-11	-	250	30	280	400	-	1,000	1,800	3,200
12c-12	530	260	90	880	4,100	200	-	1,900	6,200
12c-13	200	100	40	340	2,100	100	-	900	3,100
12c-14	390	200	70	660	3,400	200	-	1,600	5,200
	129,570	113,430	18,180	161,180 2/	551,500	126,090	951,700	566,660	2,195,950 3/

1/ Flood plain acres inundated by the Gathright Dam.

2/ Includes 48,000 acres on the main stem of the James River and its major tributaries.

3/ Does not include damages on the main stem of the James River and major tributaries, nor does it account for an increase in per capita income.

Appendix B. Table 1. Employment by industry, Subarea 1, 1940-1960, James River Basin

Industry	Employment In 1940	Employment In 1960	Percent Change
1. Armed Forces	0	123	
2. Apparel Manufacturing	14	343	
3. Electrical and Other Machinery Mfg.	24	114	373
4. Textile Mill Products Mfg.	1,278	3,393	166
5. Other Transportation Equipment Mfg.	4	10	156
6. Other Transportation	106	251	137
7. Utilities and Sanitary Service	193	392	104
8. Food and Kindred Product Mfg.	219	407	86
9. Communications	111	205	86
10. Printing and Publishing Mfg.	105	191	83
11. Finance, Insurance, and Real Estate	275	483	76
12. Medical, Other Professional Service	1,865	3,219	73
13. Lumber, Wood Products, Furniture Mfg.	722	1,195	69
14. Forestry and Fisheries	58	97	66
15. Other Retail Trade	1,549	2,473	60
16. Industry Not Reported	340	535	58
17. Public Administration	576	862	50
18. Wholesale Trade	222	327	48
19. Eating and Drinking Places	373	550	48
20. Other and Miscellaneous Mfg.	2,540	3,683	45
21. Food and Dairy Products Store	584	723	24
22. Hotel and Other Personal Service	1,420	1,686	19
23. Contract Construction	1,530	1,773	16
24. Trucking and Warehousing	256	294	15
25. Business and Repair Service	327	362	11
26. All Industries	27,352	30,240	11
27. Railroad and Railway Express	1,731	1,612	-7
28. Entertainment, Recreation Service	195	160	-18
29. Mining	461	302	-24
30. Private Households	1,822	1,157	-36
31. Chemicals and Allied Products Mfg.	1,197	568	-52
32. Agriculture	7,252	2,740	-62
33. Motor Vehicles and Equipment Mfg.	3	0	-100

Appendix B. Table 2. Employment by industry, Subarea 2, 1940-1960, James River Basin

	Industry	Employment In 1940	Employment In 1960	Percent Change
1.	Armed Forces	0	382	Inf.
2.	Electrical and Other Machinery Mfg.	185	2,807	1,417
3.	Forest and Fisheries	54	175	223
4.	Food and Kindred Products Mfg.	769	1,984	158
5.	Industry Not Reported	1,063	2,607	145
6.	Finance, Insurance, and Real Estate	1,172	2,849	143
7.	Motor Vehicles and Equipment Mfg.	29	51	125
8.	Printing and Publishing Mfg.	424	936	121
9.	Other Transportation	390	822	111
10.	Medical, Other Professional Service	6,074	12,709	109
11.	Communications	439	868	98
12.	Apparel Manufacturing	1,422	2,725	92
13.	Eating and Drinking Places	905	1,682	86
14.	Utilities and Sanitary Service	505	923	83
15.	Public Administration	1,742	3,063	Inf.
16.	Contract Construction	3,687	6,066	65
17.	Other Retail Trade	5,014	7,925	58
18.	Wholesale Trade	1,177	1,840	56
19.	Trucking and Warehousing	631	951	51
20.	Other Miscellaneous Mfg.	4,813	6,837	42
21.	Business and Repair Services	967	1,368	41
22.	Lumber, Wood Products, Furniture Mfg.	3,308	4,506	36
23.	Entertainment, Recreation Service	384	523	36
24.	Chemicals and Allied Products Mfg.	735	975	33
25.	Food and Dairy Products Stores	1,597	2,021	27
26.	All Industries	75,495	88,674	17
27.	Hotel and Other Personal Services	2,356	2,624	11
28.	Mining	787	720	-8
29.	Private Households	6,260	5,250	-16
30.	Railroad and Railway Express	2,391	1,701	-29
31.	Textile Mill Products Mfg.	2,239	1,446	-35
32.	Agriculture	23,886	9,321	-61
33.	Other Transportation Equipment Mfg.	82	17	-76

Appendix B. Table 3. Employment by industry, Subarea 3, 1940-1960, James River Basin

	Industry	Employment In 1940	Employment In 1960	Percent Change
1.	Armed Forces	0	7,585	Inf
2.	Industry Not Reported	1,257	10,198	1,315
3.	All Industries	43,431	217,736	401
4.	Electrical and Other Machinery Mfg.	666	1,796	170
5.	Other Transportation Equipment Mfg.	290	783	170
6.	Communications	1,386	3,551	156
7.	Medical, Other Professional Service	10,961	26,887	145
8.	Public Administration	6,144	14,105	130
9.	Trucking and Warehousing	1,513	3,128	107
10.	Business and Repair Services	2,006	4,100	104
11.	Printing and Publishing Mfg.	2,260	4,319	91
12.	Finance, Insurance, and Real Estate	6,413	11,775	84
13.	Food and Kindred Products Mfg.	3,309	5,819	76
14.	Eating and Drinking Places	2,565	4,405	72
15.	Contract Construction	8,332	13,684	64
16.	Other Retail Trade	13,833	22,593	63
17.	Wholesale Trade	5,099	8,192	61
18.	Other Transportation	1,487	2,248	51
19.	Utilities and Sanitary Service	1,677	2,489	49
20.	Apparel Manufacturing	1,875	2,706	44
21.	Chemicals and Allied Products Mfg.	5,745	8,184	42
22.	Motor Vehicles and Equipment Mfg.	186	226	22
23.	Entertainment, Recreation Services	1,063	1,267	19
24.	Other Miscellaneous Mfg.	21,203	23,690	12
25.	Hotel and Other Personal Service	6,662	7,443	12
26.	Forestry and Fisheries	351	364	4
27.	Food and Dairy Products Stores	5,188	4,963	-4
28.	Railroad and Railway Express	5,493	4,661	-15
29.	Lumber, Wood Products, Furniture Mfg.	3,285	2,783	-15
30.	Private Households	12,964	8,989	-31
31.	Agriculture	9,214	4,445	-52
32.	Mining	243	106	-56
33.	Textile Mill Products Mfg.	761	251	-67

Appendix B. Table 4. Employment by industry, 1940-1960, James River Basin

Industry	Total Basin Employment In 1940	1960	Percent Change
1. Armed Forces	0	8,090	Inf.
2. Electrical and Other Machinery Mfg.	875	4,717	439
3. Communications	1,936	4,624	139
4. Medical, Other Professional Service	18,900	42,815	127
5. Other Transportation Equipment Mfg.	376	810	116
6. Public Administration	8,462	18,030	113
7. Printing and Publishing Mfg.	2,789	5,446	95
8. Finance, Insurance, and Real Estate	7,860	15,107	92
9. Food and Findred Products Mfg.	4,297	8,210	91
10. Trucking and Warehousing	2,400	4,373	82
11. Business and Repair Services	3,300	5,830	77
12. Apparel Manufacturing	3,311	5,774	74
13. Eating and Drinking Places	3,843	6,637	73
14. Industry Not Reported	2,660	13,340	71
15. Other Transportation	1,983	3,321	68
16. Utilities and Sanitary Service	2,375	3,844	62
17. Other Retail Trade	20,396	32,991	62
18. Contract Construction	13,549	21,523	59
19. Wholesale Trade	6,498	10,359	59
20. Forestry and Fisheries	463	636	37
21. All Industries	246,278	336,650	37
22. Motor Vehicles and Equipment Mfg.	218	277	29
23. Chemicals and Allied Products Mfg.	7,677	9,727	27
24. Other and Miscellaneous Mfg.	28,556	34,210	20
25. Textile Mill Products Mfg.	4,278	5,090	19
26. Entertainment, Recreation Service	1,642	1,950	19
27. Lumber, Wood Products, Furniture Mfg.	7,315	8,484	16
28. Hotel and Other Personal Services	10,438	11,753	13
29. Food and Dairy Products Store	7,369	7,707	5
30. Railroad and Railway Express	9,615	7,984	-17
31. Mining	1,491	1,128	-24
32. Private Households	21,046	15,396	-27
33. Agriculture	40,352	16,506	-59

Methodology for Tables 5, 6, 7 and 8

The figure in the National Growth column represents the employment increase that would have occurred in the region if the particular industry in the region had grown at the National rate for all industries in the same period. The figure in the Industrial Mix column represents an adjustment for the growth rate of the industry. A positive figure in this column indicates that the industry grew more rapidly than all other industries combined. The final element of change, the Regional Share, represents an adjustment for the growth rate of the industry within the region. A positive figure indicates the industry grew more rapidly in the region than in the Nation. Minus signs preceeding numbers in the Industrial Mix column indicate industries which have lagged behind the National growth rate for all industries. Minus signs in the Regional Share column indicate that employment in these industries grew less rapidly in the region than in the Nation as a whole.

Appendix B. Table 5. Components of employment change, 1940-1960, James River Basin

Industry	Components of Employment Change			
	Change Related To			Total Change
	National Growth	Industrial Mix	Regional Share	
1. Agriculture	15,157	-33,328	-5,675	-23,846
2. Forestry and Fisheries	217	-304	260	173
3. Mining	583	-928	-18	-363
4. Contract Construction	6,870	4,411	-3,307	7,974
5. Food and Kindred Products Mfg.	2,020	804	1,089	3,913
6. Textile Mill Products Mfg.	2,326	-3,761	2,247	812
7. Apparel Manufacturing	1,594	-85	954	2,463
8. Lumber, Wood Products, Furniture Mfg.	3,485	-2,554	238	1,169
9. Printing and Publishing Mfg.	1,301	880	476	2,657
10. Chemicals and Allied Products Mfg.	3,531	3,277	-4,758	2,050
11. Electrical and Other Machinery Mfg.	394	921	2,527	3,842
12. Motor Vehicles and Equipment Mfg.	82	24	-47	59
13. Other Transportation Equipment Mfg.	133	303	-2	433
14. Other and Miscellaneous Mfg.	11,891	2,673	-8,910	5,654
15. Railroads and Railway Express	4,337	-5,898	-80	-1,641
16. Trucking and Warehousing	1,174	787	12	1,973
17. Other Transportation	1,088	186	64	1,338
18. Communications	1,083	1,036	569	2,688
19. Utilities and Sanitary Services	1,178	380	-1,089	1,469
20. Wholesale Trade	3,307	2,031	-1,477	3,861
21. Food and Dairy Products Stores	3,271	-2,304	-629	338
22. Eating and Drinking Places	1,976	374	444	2,794
23. Other Retail Trade	9,900	3,013	-318	12,595
24. Finance, Insurance and Real Estate	3,825	3,066	356	7,247
25. Hotels and Other Personal Services	4,608	-3,038	-255	1,315
26. Private Households	7,911	-11,676	-1,385	-5,980
27. Business and Repair Services	1,674	1,185	-329	2,530
28. Entertainment, Recreation Services	762	-321	-133	308
29. Medical, Other Professional Services	9,478	15,454	3,855	23,915
30. Public Administration	4,475	5,321	-228	9,568
31. Armed Forces	1,089	3,876	3,125	8,090
32. Industry Not Reported	1,277	6,937	2,466	10,680
All Industries	112,025	-7,260	-14,393	90,372

Appendix B. Table 6. Components of employment change, Subarea 1, 1940-1960, James River Basin

Industry	Components of Employment Change — Change Related To: National Growth	Industrial Mix	Regional Share	Total Change
1. Agriculture	2,705	-6,922	-3,044	-4,512
2. Forestry and Fisheries	26	-22	47	39
3. Mining	173	-265	-67	-159
4. Contract Construction	728	513	-998	243
5. Food and Kindred Products Mfg.	110	44	34	188
6. Textile Mill Products Mfg.	795	-1,377	2,697	2,115
7. Apparel Manufacturing	21	-7	315	329
8. Lumber, Wood Products, Furniture Mfg.	371	-295	397	473
9. Printing and Publishing Mfg.	47	32	7	86
10. Chemicals and Allied Products Mfg.	463	423	-1,515	-629
11. Electrical and Other Machinery Mfg.	10	26	54	90
12. Motor Vehicles and Equipment Mfg.	1	0	-4	-3
13. Other Transportation Equipment Mfg.	2	10	-6	6
14. Other and Miscellaneous Mfg.	1,095	244	-196	1,143
15. Railroads and Railway Express	806	-1,145	220	-119
16. Trucking and Warehousing	107	66	-135	38
17. Other Transportation	74	-1	72	145
18. Communications	58	60	-24	94
19. Utilities and Sanitary Services	98	30	71	199
20. Wholesale Trade	99	73	-67	105
21. Food and Dairy Products Stores	273	-197	63	139
22. Eating and Drinking Places	176	45	-44	177
23. Other Retail Trade	735	226	-37	924
24. Finance, Insurance and Real Estate	131	99	-22	208
25. Hotels and Other Personal Services	623	-411	54	266
26. Private Households	629	-1,016	-278	-665
27. Business and Repair Services	167	117	-249	35
28. Entertainment, Recreation Services	81	-30	-86	-35
29. Medical, Other Professional Services	869	1,346	-861	1,354
30. Public Administration	262	331	-307	286
31. Armed Forces	3	15	105	123
32. Industry Not Reported	174	1,018	-997	195
All Industries	11,912	-5,980	-3,044	2,888

Appendix B. Table 7. Components of employment change, Subarea 2, 1940-1960, James River Basin

Industry	Components of Employment Change: Change Related To: National Growth	Industrial Mix	Regional Share	Total Change
1. Agriculture	8,980	-19,756	-3,789	-14,565
2. Forestry and Fisheries	28	-40	143	121
3. Mining	314	-507	126	-67
4. Contract Construction	1,900	1,191	-712	2,379
5. Food and Kindred Products Mfg.	353	137	799	1,215
6. Textile Mill Products Mfg.	1,043	-1,533	-303	-793
7. Apparel Manufacturing	683	-36	656	1,303
8. Lumber, Wood Products, Furniture Mfg.	1,655	-1,288	831	1,198
9. Printing and Publishing Mfg.	212	148	152	512
10. Chemicals and Allied Products Mfg.	322	297	-379	240
11. Electrical and Other Machinery Mfg.	90	205	2,327	2,622
12. Motor Vehicles and Equipment Mfg.	11	5	6	22
13. Other Transportation Equipment Mfg.	28	55	-148	-65
14. Other and Miscellaneous Mfg.	2,110	472	-558	2,024
15. Railroads and Railway Express	1,078	-1,461	-307	-690
16. Trucking and Warehousing	287	187	-154	320
17. Other Transportation	231	25	176	432
18. Communications	233	235	-39	429
19. Utilities and Sanitary Services	286	78	54	418
20. Wholesale Trade	569	374	-280	663
21. Food and Dairy Products Stores	750	-548	222	424
22. Eating and Drinking Places	454	96	227	777
23. Other Retail Trade	2,373	735	-197	2,911
24. Finance, Insurance and Real Estate	553	422	702	1,677
25. Hotels and Other Personal Services	1,046	-688	-90	268
26. Private Households	2,368	-3,473	95	-1,010
27. Business and Repair Services	473	342	-414	401
28. Entertainment, Recreation Services	186	-81	34	139
29. Medical, Other Professional Services	2,969	4,755	-1,089	6,635
30. Public Administration	834	1,027	-540	1,321
31. Armed Forces	28	99	255	382
32. Industry Not Reported	517	2,863	-1,836	1,544
All Industries	32,959	-15,676	-4,104	13,179

Appendix B. Table 8. Components of employment change, Subarea 3, 1940-1960, James River Basin

Industry	Components of Employment Change			
	Change Related to:			Total Change
	National Growth	Industrial Mix	Regional Share	
1. Agriculture	3,472	-7,650	-591	-4,769
2. Forestry and Fisheries	163	-220	70	13
3. Mining	96	-156	-77	-137
4. Contract Construction	4,242	2,707	-1,597	5,352
5. Food and Kindred Products Mfg.	1,557	623	330	2,510
6. Textile Mill Products Mfg.	488	-851	-147	-510
7. Apparel Manufacturing	890	-42	-17	831
8. Lumber, Wood Products, Furniture Mfg.	1,459	-971	-984	-502
9. Printing and Publishing Mfg.	1,042	700	317	2,059
10. Chemicals and Allied Products Mfg.	2,746	2,607	-2,864	2,439
11. Electrical and Other Machinery Mfg.	294	690	146	1,400
12. Motor Vehicles and Equipment Mfg.	70	19	-49	40
13. Other Transportation Equipment Mfg.	103	238	152	493
14. Other and Miscellaneous Mfg.	8,686	1,957	-8,156	2,487
15. Railroads and Railway Express	2,453	-3,292	7	-832
16. Trucking and Warehousing	780	534	301	1,615
17. Other Transportation	783	162	-184	761
18. Communications	792	741	632	2,165
19. Utilities and Sanitary Services	794			
20. Wholesale Trade	2,639	1,584	-1,130	3,093
21. Food and Dairy Products Stores	2,248	1,559	-914	-225
22. Eating and Drinking Places	1,346	233	261	1,840
23. Other Retail Trade	6,792	2,052	-84	8,760
24. Finance, Insurance and Real Estate	3,141	2,545	-324	5,362
25. Hotels and Other Personal Services	2,939	1,939	-219	781
26. Private Households	4,914	-7,187	-1,702	-3,975
27. Business and Repair Service	1,034	726	334	2,094
28. Entertainment, Recreation Services	495	-210	-81	204
29. Medical, Other Professional Services	5,640	9,353	933	15,926
30. Public Administration	3,379	3,963	619	7,961
31. Armed Forces	1,058	3,762	2,765	7,585
32. Industry Not Reported	586	3,056	5,299	8,941
All Industries	67,154	14,396	-7,245	74,305

Appendix B. Table 9. Sales of farm products, selected years 1949 through 1969, James River Basin, Virginia

Subareas and Counties	All Farm Products Sold				
	1949	1954	1959	1964	1969
	Dollars				
Subarea 1					
Alleghany	458,080	454,736	730,987	586,293	681,926
Bath	740,215	834,767	1,341,534	916,854	1,430,275
Botetourt	2,789,856	4,072,252	4,014,987	3,603,460	4,706,005
Craig	558,158	463,555	880,046	629,047	882,279
Highland	1,337,055	1,405,755	1,960,049	1,795,138	3,216,615
Rockbridge	3,090,092	3,287,853	3,732,231	3,898,282	5,541,980
Total	8,973,456	10,518,918	12,659,834	11,429,074	13,242,465
Subarea 2					
Albemarle	4,008,559	5,438,937	5,608,752	5,069,132	7,938,770
Amelia	2,393,399	2,880,196	4,400,670	4,317,313	5,281,235
Amherst	1,552,861	1,711,657	1,840,403	1,806,355	2,249,100
Appomattox	1,565,682	2,044,080	2,710,932	1,982,169	2,448,360
Buckingham	1,535,382	2,542,611	2,731,617	2,686,382	279,406
Cumberland	1,512,314	2,307,728	2,811,318	3,071,858	4,023,077
Fluvanna	798,942	868,572	1,549,567	1,509,952	2,207,505
Goochland	1,312,237	1,485,266	1,595,552	1,717,160	2,101,311
Greene	769,162	1,330,368	2,194,671	1,916,608	1,452,038
Nelson	1,671,487	2,231,570	2,004,276	1,930,481	2,901,171
Nottoway	2,146,328	2,839,826	3,532,222	4,004,212	3,917,267
Powhatan	1,268,738	1,442,516	2,034,205	2,557,716	3,308,162
Prince Edward	2,137,090	2,864,037	3,728,099	3,641,440	4,205,745
Total	22,672,181	29,994,386	35,742,284	35,210,778	42,313,147
Subarea 3					
Charles City	714,868	837,574	1,108,206	1,256,146	1,608,669
Chesterfield	1,917,859	2,067,143	2,610,340	3,006,108	2,581,056
Henrico	3,158,756	3,115,277	4,233,519	3,310,165	3,487,402
Isle of Wight	5,816,450	6,662,116	5,048,710	6,263,079	9,020,684
James City	687,927	1,046,063	1,372,450	1,044,035	1,193,143
New Kent	586,249	757,305	1,203,575	1,013,725	1,177,852
Prince George	1,494,259	1,854,664	2,581,474	2,910,481	3,252,294
Surry	2,807,343	3,198,444	3,332,064	3,646,662	5,440,288
Total	17,183,711	19,538,586	21,490,338	22,450,401	27,771,388
Basin Total	49,539,964	60,051,890	70,892,456	70,090,253	83,327,000

Source: U. S. Census of Agriculture

Appendix B. Table 9. Sales of farm products, selected years, 1949 through 1969, James River Basin, Virginia--Continued

Subareas and Counties	All Crops Sold				
	1949	1954	1959	1964	1969
Subarea 1					
Alleghany	27,369	34,654	152,508	140,006	143,306
Bath	111,130	66,634	226,762	173,473	138,268
Botetourt	733,922	1,265,233	804,586	1,079,589	929,134
Craig	20,337	33,018	109,869	108,643	113,106
Highland	33,745	30,802	99,247	55,456	135,969
Rockbridge	369,200	536,814	450,175	521,345	489,180
Total	1,295,703	1,967,155	1,843,147	2,078,512	1,949,963
Subarea 2					
Albemarle	1,148,550	1,806,347	1,031,391	1,333,370	1,148,889
Amelia	784,370	1,183,194	1,564,182	2,036,685	1,670,237
Amherst	601,373	846,976	790,026	827,005	670,878
Appomattox	874,611	1,009,965	1,239,663	1,083,380	867,298
Buckingham	595,783	699,300	856,516	839,103	669,124
Cumberland	597,072	818,607	1,002,833	891,815	791,116
Fluvanna	89,920	145,613	188,043	141,063	203,929
Goochland	218,313	279,418	420,676	511,428	473,915
Greene	81,442	103,719	195,226	118,140	63,388
Nelson	946,498	1,502,849	1,097,708	1,154,528	1,619,402
Nottoway	970,796	1,352,532	1,542,242	1,938,421	1,392,649
Powhatan	118,835	172,111	280,971	346,688	393,550
Prince Edward	1,166,628	1,583,014	1,709,056	1,848,362	1,549,206
Total	8,194,191	11,503,735	11,918,533	13,069,988	11,513,582
Subarea 3					
Charles City	370,001	495,956	612,044	680,933	1,166,448
Chesterfield	640,730	767,078	1,079,816	1,393,805	1,083,378
Henrico	940,003	758,968	1,213,747	1,426,958	1,403,666
Isle of Wight	4,158,624	4,736,471	3,750,091	4,421,439	5,782,616
James City	348,638	439,816	518,003	583,365	691,834
New Kent	268,682	364,563	587,291	791,644	751,631
Prince George	855,141	957,519	1,327,862	1,643,801	1,668,695
Surry	2,089,844	1,874,826	2,293,317	2,718,745	3,566,837
Total	9,671,663	10,395,197	11,382,225	13,583,690	16,115,105
Basin Total	19,161,557	23,866,087	25,143,905	28,732,190	29,578,650

Appendix B. Table 9. Sales of farm products, selected years, 1949 through 1964, James River Basin, Virginia--Continued

Subareas and Counties	Field Crops Sold 1949	Field Crops Sold 1964	Fruits and Nuts Sold 1949	Fruits and Nuts Sold 1964
	Dollars			
Subarea 1				
Alleghany	15,736	34,353	2,085	2,908
Bath	36,606	68,593	1,937	1,518
Botetourt	123,134	187,477	568,815	836,703
Craig	18,622	64,563	974	3,657
Highland	26,173	13,674	7,447	4,664
Rockbridge	285,728	217,461	79,139	76,887
Total	505,999	586,121	660,397	926,337
Subarea 2				
Albemarle	203,205	429,503	912,818	461,092
Amelia	783,112	1,793,377	579	855
Amherst	320,287	379,759	266,267	319,663
Appomattox	869,456	966,442	1,169	2,626
Buckingham	440,098	589,892	155,080	35,430
Cumberland	592,773	768,011	1,302	4,014
Fluvanna	86,086	86,512	1,363	170
Goochland	165,879	390,046	1,536	4,456
Greene	45,671	75,655	2,575	1,044
Nelson	215,674	273,441	728,385	808,164
Nottoway	945,408	1,789,600	22,088	22,118
Powhatan	115,559	260,944	1,140	651
Prince Edward	1,096,316	1,625,627	66,598	76,534
Total	5,879,524	9,428,809	2,160,900	1,736,817
Subarea 3				
Charles City	367,987	625,944	218	201
Chesterfield	280,917	579,557	3,573	3,065
Henrico	139,982	410,663	5,981	4,675
Isle of Wight	4,148,363	4,334,305	515	3,873
James City	285,598	411,073	5,019	5,592
New Kent	228,088	615,215	231	369
Prince George	850,891	1,454,359	778	2,120
Surry	2,087,524	2,600,462	349	5,921
Total	8,389,350	11,030,578	16,664	25,816
Basin Total	14,774,873	21,045,508	2,837,961	2,688,970

Appendix B. Table 9. Sale of farm products, selected years, 1949 through 1964, James River Basin, Virginia--Continued

Subareas and Counties	Vegetables Sold			
	1949	1954	1959	1964
Subarea 1				
Alleghany	2,388	180	2,660	-
Bath	2,570	820	448	1,561
Botetourt	32,267	23,930	16,235	9,158
Craig	666	396	50	916
Highland	125	66	-	-
Rockbridge	4,183	3,574	2,554	2,608
Total	42,199	28,966	21,947	14,243
Subarea 2				
Albemarle	15,971	15,296	10,880	11,684
Amelia	489	1,496	1,090	-
Amherst	14,269	6,764	6,172	10,274
Appomattox	3,986	1,746	3,637	4,598
Buckingham	605	2,000	1,135	1,853
Cumberland	2,543	705	655	488
Fluvanna	2,218	2,471	3,453	360
Goochland	50,873	28,777	20,184	26,550
Greene	646	1,258	600	13,702
Nelson	1,258	1,529	1,264	250
Nottoway	2,681	3,816	280	2,654
Powhatan	2,136	815	5,705	7,595
Prince Edward	2,964	1,447	3,702	1,615
Total	100,639	68,010	58,757	81,623
Subarea 3				
Charles City	1,796	900	755	8,353
Chesterfield	15,591	15,281	21,505	15,273
Henrico	37,326	14,341	21,855	23,445
Isle of Wight	9,714	57,184	39,299	41,666
James City	58,021	96,038	132,135	133,950
New Kent	40,363	33,549	47,530	57,006
Prince George	3,472	11,248	2,565	8,041
Surry	1,971	2,305	820	5,342
Total	168,254	230,846	266,464	293,076
Basin Total	311,092	327,822	347,168	388,942

Appendix B. Table 9. Sales of farm products, selected years, 1949 through 1964, James River Basin, Virginia--Continued

Subareas and Counties	Forest Products and Horticultural Specialty Products Sold	
	1949	1964
Subarea 1		
Alleghany	46,062	102,745
Bath	138,192	101,801
Botetourt	106,549	46,251
Craig	28,420	39,507
Highland	72,278	37,118
Rockbridge	95,127	224,389
Total	486,628	551,811
Subarea 2		
Albemarle	148,292	431,091
Amelia	126,539	242,453
Amherst	99,063	117,309
Appomattox	44,389	109,714
Buckingham	84,533	211,928
Cumberland	94,145	119,302
Fluvanna	75,841	54,021
Goochland	62,588	90,376
Greene	49,438	27,739
Nelson	121,450	72,673
Nottoway	65,922	124,049
Powhatan	59,200	77,498
Prince Edward	72,588	144,586
Total	1,103,988	1,822,739
Subarea 3		
Charles City	49,834	46,435
Chesterfield	421,743	795,910
Henrico	791,862	988,175
Isle of Wight	108,684	41,595
James City	9,842	32,750
New Kent	33,113	43,054
Prince George	39,807	179,281
Surry	37,211	107,020
Total	1,492,096	2,234,220
Basin Total	3,082,712	4,608,770

Appendix B. Table 9. Sales of farm products, selected years, 1949 through 1969, James River Basin, Virginia--Continued

Subareas and Counties	Livestock, Poultry and their Products				
	1949	1954	1959	1964	1969
Subarea 1					
Alleghany	391,809	391,263	578,479	446,086	522,533
Bath	560,910	688,445	1,114,772	692,806	1,256,809
Botetourt	1,959,091	2,731,735	3,210,401	2,520,286	3,739,091
Craig	509,476	402,046	770,177	518,225	748,172
Highland	1,231,032	1,277,761	1,860,802	1,735,917	3,025,077
Rockbridge	2,625,915	2,673,917	3,282,056	3,374,056	4,920,398
Total	7,278,233	8,165,167	10,816,687	9,287,376	14,212,080
Subarea 2					
Albemarle	2,728,273	3,426,342	4,577,361	3,718,760	6,648,621
Amelia	1,482,680	1,590,149	2,936,488	2,277,633	3,425,107
Amherst	852,975	720,110	1,050,377	977,930	1,472,574
Appomattox	646,682	970,775	1,471,269	898,757	1,520,348
Buckingham	855,066	1,715,704	1,875,101	1,843,415	3,213,230
Cumberland	821,551	1,403,937	1,808,385	2,175,393	3,160,028
Fluvanna	633,434	647,780	1,361,524	1,338,209	1,963,621
Goochland	1,031,361	1,144,213	1,174,876	1,201,474	1,533,727
Greene	670,832	1,192,627	1,999,445	1,797,988	1,378,743
Nelson	604,720	659,191	906,568	774,076	1,208,806
Nottoway	1,110,229	1,419,050	1,989,980	2,063,938	2,390,452
Powhatan	1,090,703	1,224,554	1,753,234	2,209,943	2,889,226
Prince Edward	898,624	1,178,288	2,019,043	1,792,077	2,551,781
Total	13,427,130	17,292,720	24,823,751	23,069,593	33,356,264
Subarea 3					
Charles City	295,033	294,529	496,162	550,698	348,790
Chesterfield	1,196,035	1,224,541	1,530,524	1,601,391	1,461,053
Henrico	2,183,605	2,307,949	3,019,772	1,881,342	2,034,972
Isle of Wight	1,549,174	1,872,589	1,298,619	1,841,014	3,083,590
James City	329,447	569,446	854,447	459,644	498,069
New Kent	284,454	354,322	616,284	289,575	410,690
Prince George	599,311	865,709	1,253,612	1,263,305	1,563,104
Surry	680,288	1,251,488	1,038,693	927,693	1,769,797
Total	7,117,347	8,740,573	10,108,113	8,814,662	11,170,065
Basin Total	27,822,710	34,198,460	45,748,551	41,171,631	58,738,409

Appendix B. Table 9. Sales of farm products, selected years, 1949 through 1964, James River Basin, Virginia--Continued

Subareas and Counties	Dairy Products Sold		Poultry and Poultry Products Sold	
	1949	1964	1949	1964
Subarea 1				
Alleghany	169,060	145,783	24,840	58,431
Bath	56,999	56,449	113,689	181,410
Botetourt	871,763	894,087	284,046	673,787
Craig	57,026	107,669	52,146	28,637
Highland	35,588	84,217	133,418	716,324
Rockbridge	651,348	797,728	346,073	879,611
Total	1,841,784	2,085,933	954,212	2,538,200
Subarea 2				
Albemarle	613,572	891,211	378,659	338,559
Amelia	943,556	1,600,989	182,447	130,489
Amherst	197,055	274,280	101,685	28,485
Appomattox	189,493	441,852	183,939	76,999
Buckingham	97,813	263,512	453,245	989,251
Cumberland	261,611	924,470	269,146	775,248
Fluvanna	91,612	121,775	199,436	556,502
Goochland	263,739	300,964	239,892	314,981
Greene	136,740	162,089	120,994	1,195,907
Nelson	77,375	75,710	73,722	109,674
Nottoway	655,303	975,958	168,137	714,725
Powhatan	534,925	1,287,143	281,123	469,900
Prince Edward	524,411	1,356,160	101,867	87,313
Total	4,587,205	8,676,113	2,754,291	5,788,033
Subarea 3				
Charles City	47,301	97,075	66,610	65,961
Chesterfield	382,327	628,647	547,383	636,724
Henrico	820,894	672,529	946,960	868,293
Isle of Wight	296,094	232,238	233,196	311,226
James City	177,467	187,276	45,679	17,185
New Kent	58,203	42,840	85,680	58,849
Prince George	130,761	283,494	142,177	413,916
Surry	37,020	66,631	77,514	76,430
Total	1,950,067	2,210,730	2,145,199	2,448,584
Basin Total	8,379,056	12,972,776	5,853,702	10,774,817

Appendix B. Table 9. Sales of farm products, selected years, 1949 through 1964, James River Basin, Virginia--Continued

Subareas and Counties	Other Livestock and Livestock Products Sold	
	1949	1964
Subarea 1		
Alleghany	197,909	241,872
Bath	390,222	454,947
Botetourt	803,282	952,412
Craig	400,304	381,919
Highland	1,062,026	935,376
Rockbridge	1,628,494	1,697,657
Total	4,482,237	4,664,183
Subarea 2		
Albemarle	1,736,042	2,488,990
Amelia	356,677	546,155
Amherst	554,235	675,165
Appomattox	273,251	379,906
Buckingham	304,008	590,652
Cumberland	290,794	475,675
Fluvanna	342,386	485,047
Goochland	527,730	620,521
Greene	413,098	439,992
Nelson	453,623	588,692
Nottoway	286,789	373,255
Powhatan	274,655	452,900
Prince Edward	272,346	348,604
Total	6,085,634	8,465,554
Subarea 3		
Charles City	181,122	387,662
Chesterfield	266,325	336,020
Henrico	415,751	340,520
Isle of Wight	1,019,884	1,297,550
James City	106,301	255,183
New Kent	140,571	187,886
Prince George	326,373	565,895
Surry	565,754	784,794
Total	3,022,081	4,155,510
Basin Total	13,589,952	17,285,247

Appendix B. Table 10. Acres of major field crops, selected years, 1949 through 1969, James River Basin

Subareas and Counties	Hay Crops			Corn for Grain			Sorghum cut for silage			Soybeans for Beans		
	1949	1964	1969	1949	1964	1969	1949	1964	1969	1949	1964	1969
Subarea 1												
Alleghany	4,721	3,462	3,487	1,414	289	454	9	5	42	-	-	235
Bath	7,077	7,111	5,683	1,475	431	416	34	33	-	-	33	-
Botetourt	15,670	12,386	11,303	3,766	1,439	1,461	187	87	92	36	5	21
Craig	7,115	6,655	4,776	1,473	505	528	45	-	58	-	-	-
Highland	11,544	9,878	10,258	1,044	143	248	-	51	-	-	-	-
Rockbridge	19,566	17,227	16,606	6,621	1,584	1,489	13	25	32	26	5	-
Total	65,693	56,719	52,113	15,793	4,391	4,596	288	164	224	62	43	256
Subarea 2												
Albemarle	30,823	27,855	22,930	8,474	2,431	2,780	85	240	285	217	88	215
Amelia	13,191	9,370	5,563	6,665	3,507	3,069	267	89	68	213	3,178	6,329
Amherst	10,264	10,139	7,748	5,423	1,800	875	13	-	18	-	25	28
Appomattox	8,895	6,671	6,540	7,233	4,322	2,311	5	-	10	3	21	106
Buckingham	11,129	8,220	8,470	8,929	3,643	2,391	12	45	105	15	64	139
Cumberland	8,592	7,334	5,648	6,866	2,671	2,597	160	419	408	57	100	740
Fluvanna	9,159	6,279	7,451	4,058	947	583	75	182	26	198	78	127
Goochland	11,203	11,390	7,394	5,171	3,004	1,756	143	86	93	133	598	660
Greene	6,876	7,265	4,410	4,071	1,088	543	-	-	14	-	-	-
Nelson	11,487	11,884	8,167	6,071	1,916	1,057	-	-	51	15	-	20
Nottoway	9,163	6,692	4,267	5,560	2,442	1,387	204	177	320	49	1,428	2,932
Powhatan	6,820	6,439	4,087	3,425	1,536	1,283	4	64	41	74	478	664
Prince Edward	10,141	9,284	6,391	8,321	3,871	2,620	165	287	227	35	211	569
Total	147,743	128,822	99,066	80,267	33,178	23,252	1,133	1,589	1,666	1,009	6,269	12,529
Subarea 3												
Charles City	1,731	1,481	512	3,831	2,939	4,588	38	22	34	2,786	5,050	5,079
Chesterfield	4,832	3,843	1,805	4,360	1,702	1,204	124	16	123	539	1,700	1,573
Henrico	7,953	4,288	2,262	3,358	1,731	2,918	83	17	25	1,437	4,745	3,199
Isle of Wight	480	299	536	21,561	17,028	17,292	73	20	135	1,229	8,142	7,884
James City	1,622	1,172	1,394	1,881	1,422	3,563	40	90	30	2,357	3,161	3,473
New Kent	1,322	1,314	835	3,237	3,576	3,974	-	-	-	2,574	4,549	4,198
Prince George	2,356	2,644	1,577	7,979	5,744	5,430	45	77	81	3,198	6,915	6,022
Surry	711	119	196	11,866	9,107	9,753	-	-	-	1,603	7,375	7,179
Total	21,007	15,160	9,117	58,073	43,249	48,722	403	242	428	15,723	41,637	38,607
Basin Total	234,443	200,701	160,296	154,133	80,818	76,570	1,824	1,995	2,318	16,794	47,949	51,392

Appendix B. Table 10. Acres of major field crops, selected years, 1949 through 1969, James River Basin--Continued

Subareas and Counties	Corn cut for silage 1949	Corn cut for silage 1964	Corn cut for silage 1969	Sorghum for grain or seed 1949	Sorghum for grain or seed 1964	Sorghum for grain or seed 1969	Peanuts for picking or threshing 1949	Peanuts for picking or threshing 1964	Peanuts for picking or threshing 1969	Small Grains harvested 1949	Small Grains harvested 1964	Small Grains harvested 1969
Subarea 1												
Alleghany	132	372	206	-	-	-	-	-	-	747	69	68
Bath	111	420	949	-	-	-	-	-	-	1,427	302	234
Botetourt	967	1,842	1,903	6	-	38	-	-	-	5,481	1,724	1,189
Craig	36	203	399	-	-	10	-	-	-	1,709	316	247
Highland	55	244	619	-	-	-	-	-	-	1,170	176	89
Rockbridge	414	2,229	2,337	17	7	-	-	-	-	10,614	3,106	1,706
Total	1,715	5,300	6,413	23	7	48	-	-	-	21,148	5,693	3,533
Subarea 2												
Albemarle	689	2,199	2,665	13	-	-	-	-	-	8,726	2,995	1,743
Amelia	554	2,311	2,927	59	21	285	-	-	-	10,149	7,654	7,811
Amherst	159	918	767	-	-	30	-	-	-	3,194	697	359
Appomattox	161	1,157	1,312	7	1	-	-	-	-	6,660	4,713	2,946
Buckingham	83	1,404	1,550	40	8	5	-	-	10	6,490	4,321	2,883
Cumberland	206	1,623	1,581	44	150	149	-	-	-	5,140	3,092	2,923
Fluvanna	134	466	479	42	1	27	-	-	-	3,267	1,446	957
Goochland	416	1,060	823	6	40	11	-	7	-	3,827	4,189	2,923
Greene	178	488	381	-	-	-	-	-	-	3,286	846	258
Nelson	42	597	351	-	1	-	-	-	-	3,105	897	165
Nottoway	201	1,079	1,448	74	-	128	1	-	-	5,150	3,605	3,427
Powhatan	442	1,730	1,653	-	34	120	1	-	-	2,846	2,036	1,640
Prince Edward	342	1,317	1,856	4	2	397	-	-	-	7,130	5,608	4,937
Total	3,607	16,449	17,793	289	258	1,152	2	7	10	68,970	42,099	32,972
Subarea 3												
Charles City	205	402	245	32	10	118	-	-	(D)	3,747	3,936	3,139
Chesterfield	376	1,279	1,005	100	12	51	79	28	22	2,581	1,475	1,338
Henrico	1,083	1,230	859	-	-	71	-	-	-	4,441	3,503	3,364
Isle of Wight	257	679	962	197	26	200	19,943	14,812	15,336	654	2,433	2,524
James City	243	317	237	-	-	74	144	129	66	1,631	1,395	2,607
New Kent	49	87	339	20	-	-	86	-	215	1,714	1,894	2,093
Prince George	312	590	749	290	179	60	5,257	3,745	3,226	3,778	2,805	2,387
Surry	69	130	222	349	210	103	11,070	8,692	8,640	1,461	2,317	1,787
Total	2,594	4,714	4,618	988	437	677	36,579	27,406	27,505	20,007	19,758	19,239
Basin Total	7,916	26,463	28,824	1,300	702	1,877	36,581	27,413	27,515	110,125	65,171	55,744

(D) Withheld to avoid disclosure of information for individual farms.

Appendix B. Table 11. Livestock and poultry numbers on farms, 1949, 1964 and 1969, James River Basin

Subareas and Counties	Cattle and Calves Less Milk Cows			Milk Cows			Hogs and Pigs		
	1949	1964	1969	1949	1964	1969	1949	1964	1969
Subarea 1									
Alleghany	2,849	2,923	3,793	1,560	732	206	1,395	449	500
Bath	4,963	5,649	8,280	925	248	202	2,319	1,429	1,198
Botetourt	10,665	14,914	17,513	5,781	2,455	2,777	4,673	1,732	1,946
Craig	6,368	4,534	5,847	1,493	719	405	1,875	986	1,054
Highland	10,027	6,621	9,932	1,723	709	663	2,555	777	826
Rockbridge	19,899	20,973	27,220	6,739	2,347	1,626	8,517	3,238	3,212
Total	54,671	55,614	72,585	18,221	7,310	5,879	21,334	8,611	8,736
Subarea 2									
Albemarle	20,640	31,141	32,470	6,265	2,788	1,815	11,609	5,162	5,385
Amelia	5,081	7,921	7,475	4,684	3,853	3,732	5,015	4,328	6,379
Amherst	7,437	11,931	12,397	3,349	1,103	698	3,613	1,496	939
Appomattox	3,818	6,336	8,859	2,763	1,677	1,184	3,293	2,022	2,521
Buckingham	4,510	9,528	11,533	2,682	1,112	893	5,902	3,374	5,425
Cumberland	3,884	7,333	8,218	2,571	2,407	1,932	4,666	3,814	5,135
Fluvanna	4,246	7,657	9,563	2,097	655	337	3,828	1,710	1,630
Goochland	5,050	9,895	8,957	2,542	1,191	665	5,461	5,124	4,083
Greene	5,362	6,946	5,605	2,586	1,228	333	5,545	2,640	1,525
Nelson	6,509	11,252	10,267	3,170	938	210	3,704	1,584	825
Nottoway	4,168	5,866	6,171	3,448	2,299	2,116	4,254	2,258	1,809
Powhatan	3,626	4,903	4,845	2,524	2,599	2,076	3,192	3,012	2,223
Prince Edward	3,881	7,303	8,688	3,563	3,427	2,892	4,652	2,554	3,127
Total	78,212	128,012	135,048	42,244	25,277	18,833	64,734	39,078	41,006
Subarea 3									
Charles City	1,569	2,310	1,332	399	259	105	2,335	1,238	1,583
Chesterfield	2,603	3,312	2,548	1,978	1,387	1,069	5,634	2,391	4,340
Henrico	4,777	4,611	3,919	3,118	1,584	1,136	5,111	2,635	3,611
Isle of Wight	2,093	4,808	6,321	2,032	645	430	31,225	21,781	25,696
James City	720	1,730	1,744	751	449	250	2,112	2,109	3,340
New Kent	911	1,772	1,151	483	159	149	3,631	2,747	3,067
Prince George	1,453	3,827	3,832	1,116	800	712	9,351	8,798	9,021
Surry	1,119	2,293	2,115	745	306	251	18,605	13,832	17,925
Total	15,245	24,663	22,962	10,577	5,589	4,102	78,004	55,531	68,583
Basin Total	148,218	208,289	230,595	71,042	38,176	28,814	164,072	103,220	118,325

Appendix B. Table 11. Livestock and poultry numbers on farms, 1949, 1964 and 1969, James River Basin--Continued

Subareas and Counties	Sheep and Lambs			Chickens			Turkey Hens - kept for breeding		
	1949	1964	1969	1949	1964	1969	1949	1964	1969
Subarea 1									
Alleghany	3,367	1,483	751	16,612	7,128	1,863	37	0	0
Bath	8,631	4,286	4,970	13,962	6,480	1,375	55	714	(D)
Botetourt	1,663	1,589	1,311	64,156	68,203	36,419	56	13	6
Craig	4,613	2,368	4,012	19,212	10,603	4,156	65	42	1
Highland	24,922	17,970	22,353	18,824	8,095	4,060	472	(D)	(D)
Rockbridge	16,808	6,079	7,380	82,234	37,121	20,832	166	56	12
Total	60,004	33,775	40,777	215,000	137,630	68,705	851	986	19
Subarea 2									
Albemarle	7,028	2,210	1,666	69,935	60,244	97,472	3,163	22	2
Amelia	593	538	975	54,857	30,092	16,286	42	5	10
Amherst	573	396	290	42,271	16,239	6,004	28	6	-
Appomattox	155	170	(D)	37,255	13,513	7,374	1,184	49	-
Buckingham	842	485	366	60,035	29,987	19,327	623	(D)	-
Cumberland	476	232	216	44,602	49,477	43,884	851	(D)	24
Fluvanna	1,318	523	509	47,447	115,905	105,379	32	12	3
Goochland	407	649	98	61,075	24,450	9,769	63	3	-
Greene	1,851	776	643	36,033	69,825	77,037	2,171	1,352	(D)
Nelson	2,046	616	838	49,803	15,097	7,937	27	5	(D)
Nottoway	355	432	861	48,819	125,677	36,939	15	0	9
Powhatan	248	244	142	40,727	69,057	99,449	41	0	3
Prince Edward	233	115	64	52,457	20,050	12,792	50	27	-
Total	16,125	7,386	6,668	645,316	639,613	539,649	8,290	2,222	51
Subarea 3									
Charles City	943	228	85	21,333	8,819	7,677	21	0	25
Chesterfield	583	416	56	105,090	91,287	38,501	165	5	1,033
Henrico	298	68	133	114,196	72,968	49,506	44	4	5
Isle of Wight	552	620	573	57,119	41,758	32,248	19	6	-
James City	68	142	16	11,342	4,852	1,607	10	0	-
New Kent	201	385	(D)	25,392	12,047	1,994	9	1	-
Prince George	403	66	23	40,607	60,925	9,185	34	12	-
Surry	300	224	123	30,531	18,372	8,982	38	1	-
Total	3,348	2,149	1,009	405,610	311,028	149,700	340	29	1,063
Basin Total	79,477	43,310	48,454	1,265,926	1,088,271	758,054	9,481	3,237	1,133

(D) Withheld to avoid disclosure of information for individual farms.

Appendix B. Table 12. Flood plain land use and annual damages, Early Action Watersheds, James River Basin

Watershed	No. of Sites	Watershed Drainage Area	Drainage Area Above Sites	Flood Plain Land Use: Crop and Pasture	Forest land	Urban and Other	Total	Annual Flood Damages: Agricul-tural	Urban	Roads and Bridges	Indirect	Total
		Thousands of Acres						Thousands of Dollars 1/				
Subarea 1	29	615.4	262.9	29.9	3.6	5.1	37.1	71.0	610.2	43.7	156.0	880.9
Ogle Creek (12-3)	5	29.3	16.1	0.4	0.2	0.1	0.6	0.1	72.9	3.2	14.2	90.4
Dunlap Creek (12-4,5)	7	78.0	28.6	1.8	0.2	0.4	2.4	5.8	84.6	4.4	19.8	114.6
Upper Jackson (12-6,7)	4	100.2	40.4	4.8	0.6	0.5	5.9	8.4	110.9	6.4	26.3	151.9
Cowpasture River (12-12,13,14)	6	248.4	118.0	18.7	1.0	2.2	22.0	44.4	227.2	21.5	61.4	354.6
Jackson River 5 (12-15)	3	73.3	23.9	0.1	0.4	0.1	0.7	0.0	83.1	2.3	23.0	108.5
Tye River (12-25)	4	86.3	36.0	2.4	0.4	0.2	3.0	12.4	31.5	5.9	11.2	60.9
Subarea 2	28	486.6	171.0	13.1	3.5	1.4	18.0	78.6	159.2	52.0	67.9	357.7
Piney River (12-26)	3	45.1	22.0	1.4	0.2	0.3	1.9	2.6	49.0	3.3	11.8	66.7
Hardware River (12-30)	6	88.4	28.3	4.6	0.7	0.2	5.4	18.9	0	4.6	4.7	28.2
James River 5 (12-36)	2	96.8	7.0	2.0	0.6	0.5	3.1	2.7	19.4	5.4	6.9	34.3
Beaver Creek (12-43)	2	23.7	6.0	0.3	0.1	0.2	0.5	2.2	2.3	2.8	2.0	9.4
Calfpasture River (12a-1)	8	119.3	39.1	4.0	1.1	0.4	5.5	13.5	82.9	20.0	27.7	144.1
North Fork Rivanna (12b-1,2,7,12)	7	113.5	68.7	2.3	1.6	0.1	4.0	38.6	5.7	16.0	14.8	75.0
Total Early Action Watersheds	57	1,102.1	433.9	43.0	7.0	5.1	55.1	149.6	769.4	95.7	233.9	1,238.6

Source: Watershed Investigation Reports, SCS.

1/ Base year 1967.

Appendix B. Table 13. Agricultural data used to evaluate impacts of early action watersheds, James River Basin

Watersheds and Counties	Watershed Drainage Area	Acres in Co.	Watershed in Co.	Co. in Watershed	Co. in farms	Avg. size of farm	Avg. Value of Farmland & Bldgs.	Total Cropland	Market Value of All Agricultural Products Sold: Total	Per Farm	Per Cropland Acre
	Acres		Percent			Acres	Dol./Ac.	Acres	Dollars[1]		
Ogle Creek (12-3)	29,335										
Alleghany County	29,335	285,440	100	10	16	179.5	157	81,555	681,926	2,749	55.17
Dunlap Creek (12-4,5)	77,955										
Alleghany Co., Va.	58,655	285,440	75	21	16	179.5	157	12,361	681,926	2,749	55.17
Monroe Co., W. Va.	19,300	302,720	25	6	53	189.5	135	49,534	326,607	5,072	87.35
Upper Jackson River (12-6,7)	100,175										
Highland County	46,270	266,240	46	17	50	289.3	111	33,386	3,216,615	6,977	96.35
Bath County	53,905	345,600	54	16	21	391.3	165	22,675	1,430,275	7,567	63.08
Cowpasture River (12-12,13,14)	248,355										
Alleghany Co.	2,120	285,440	1	1	16	179.5	157	12,361	681,926	2,749	55.17
Bath Co.	134,335	345,600	54	39	21	391.3	165	22,675	1,430,275	7,567	63.08
Highland Co.	111,555	266,240	45	42	50	289.3	111	33,386	3,216,615	6,977	96.35
Pendleton Co., W.Va.	345		0								
Jackson River 5 (12-15)	73,275										
Alleghany Co.	56,195	285,440	77	20	16	179.5	157	12,361	681,926	2,745	55.17
Bath Co.	15,825	345,600	22	5	21	391.3	165	22,675	1,420,275	7,567	63.08
Botetourt Co.	255		1								

See footnotes at end of table.

Appendix B. Table 13. Agricultural data used to evaluate impacts of early action watersheds, James River Basin--Continued

Watersheds and Counties	Watershed Drainage Area	Acres in Co.	Watershed in Co.	Co. in Watershed	Co. in farms	Avg. size of farm	Avg. Value of Farmland & Bldgs.	Total Cropland	Market Value of All Agricultural Products Sold: Total	Per Farm	Per Cropland Acre
	Acres		Percent			Acres	Dol./Ac.	Acres	Dollars 1/		
Tye River (12-25)	86,320										
Amherst Co.	2,560	298,880	3	1	34	206.0	151	29,994	2,249,100	4,562	74.98
Nelson Co.	83,760	299,520	97	28	28	197.3	168	31,201	2,901,171	6,794	92.98
Piney River (12-26)	45,065										
Amherst Co.	29,345	298,880	65	10	34	206.0	151	29,994	2,249,100	4,562	74.98
Nelson Co.	15,720	200,520	35	5	28	197.3	168	31,201	2,901,171	6,794	92.98
Hardware River (12-30)	88,380										
Albemarle Co.	71,430	472,960	81	15	45	275.6	394	81,555	7,938,770	10,363	97.34
Fluvanna Co.	16,950	180,480	19	9	43	213.0	212	25,318	2,207,505	5,998	87.19
James River 5 (12-36)	96,800										
Amherst Co.	49,600	298,880	51	17	34	206.0	151	29,994	2,249,100	4,562	74.98
Appomattox Co.	16,800	219,520	17	8	42	179.6	145	33,833	2,448,360	4,772	72.37
Campbell Co.	25,300	335,360	26	8	50	177.1	167	66,727	6,345,702	6,637	95.10
Nelson Co.	5,100	299,520	5	2	28	197.3	168	31,201	2,901,171	6,794	92.98
Beaver Creek (12-43)	23,655										
Campbell Co.	23,655	335,360	100	7	50	177.1	167	66,727	6,345,702	6,637	95.10
Calfpasture River (12a-1)	119,275										
Augusta Co.	82,885	631,040	69	13	46	178.3	280	134,790	23,407,568	14,307	173.66
Rockbridge Co.	10,160	286,560	9	3	46	226.7	203	63,903	5,541,980	7,105	86.72
Bath Co.	26,230	345,600	22	8	21	391.3	165	22,675	1,430,275	7,567	63.08
North Fork Rivanna River (12b-1,2,7,12)	113,470										
Albemarle Co.	49,000	472,960	43	10	45	275.6	394	81,555	7,938,770	10,363	97.34
Greene Co.	59,920	97,920	53	61	35	149.9	215	13,409	1,452,038	6,396	108.29
Orange Co.	4,550	226,560	4	2	53	291.6	286	49,791	5,703,175	13,842	114.54

Source: Census of Agriculture and calculations.

1/ Base year 1967.

Appendix B. Table 14. Early action structural and land treatment data, James River Basin, 1967

Watershed	Structural Data: Normal Pool Area	Flood Pool Area	Flood Prevention Storage	Water Supply Storage	Recreation Storage	Addit'l Storage Available	Recommended Land Treatment: Channel Improvement	Cropland and Pasture	Forest Land and Other
	Acres		Acre-Feet				Miles	Acres	
Subarea 1	1,826	3,675	89,439	9,650	30,530	182,275	20.7	54,160	41,310
Ogle Creek (12-3)	61	203	5,385	1,000	0	13,230	0	1,590	1,750
Dunlap Creek (12-4,5)	136	333	9,524	3,150	0	22,105	0	4,220	4,680
Upper Jackson River (12-6,7)	585	862	13,775	1,000	15,835	16,955	7.9	9,870	4,930
Cowpasture River (12-12,13,14)	772	1,467	35,720	1,000	14,195	84,080	1.9	29,290	14,570
Jackson River 5 (12-15)	137	314	8,115	3,000	0	16,920	0	3,970	4,840
Tye River (12-25)	135	496	16,920	500	500	28,985	10.9	5,220	10,540
Subarea 2	2,009	4,893	80,690	6,655	18,255	113,850	21.5	53,070	41,390
Piney River (12-26)	197	405	10,475	500	3,865	10,530	0	3,340	5,230
Hardware River (12-30)	472	1,079	14,560	1,060	3,935	18,545	8.4	8,740	8,520
James River 5 (12-36)	54	189	3,060	500	0	5,350	11.6	7,420	11,010
Beaver Creek (12-43)	65	154	2,585	500	0	4,450	1.5	1,820	2,640
Calfpasture River (12a-1)	272	835	13,095	1,500	205	30,895	0	20,520	3,060
North Fork Rivanna (12b-1,2,7,12)	949	2,231	36,915	2,595	10,250	44,080	0	11,230	10,930
Total Early Action Watersheds	3,835	8,568	170,129	16,305	48,785	296,125	42.2	107,230	82,700

Source: Watershed Investigation Reports, SCS

Appendix B. Table 15. Project site easement and relocation cost data for early action watersheds, James River Basin

Watershed	Site	Pool Area: Easement Costs	Building Relocation	Road Relocation	Utility Relocation	Total	Additional Recreational Development
		Dollars[1/]					
Ogle Creek (12-3)		57,960	61,100	83,460	1,800	173,800	
	1	25,760	37,500	55,460	1,000	92,200	
	2	12,000	15,000	28,000	500	52,500	
	3	2,200				2,200	
	5	2,200	8,600		300	11,100	
	6	15,800				15,800	
Dunlap Creek (12-4)		56,500	300			[illegible]	
	1A	3,300				[illegible]	
	2	3,000				3,000	
	3A	9,800				9,800	
	4	5,900				5,900	
	5	21,000	300			21,300	
(12-5)	1A	5,700				5,700	
	2A	7,800				7,800	
Upper Jackson (12-6)		272,500	40,000	286,000	5,500	667,[illegible]	96
	1	30,000				30,000	
	1G	172,500	15,000	211,000	2,500	401,000	96
	4	50,000	25,000	55,000	2,000	132,000	
(12-7)	4	20,000		20,000	1,000	41,000	
Cowpasture River (12-12)		403,900	92,500	480,800	10,600	987,800	130
	1A	29,300	7,500	160,000	6,600	20[illegible],400	
	1B	272,500	25,000	175,000	1,000	473,500	130
(12-13)	1B	38,000	25,000	110,000	2,000	175,000	
(12-14)	1A	13,000		10,000		23,000	
	3	8,600				8,600	
	7B	42,500	35,000	25,800	1,000	104,300	
Jackson River 5 (12-15)		23,500	70,000	26,800	1,000	12[illegible]	
	1B	11,500	50,000	20,000	1,000	82,500	
	1C	6,500		6,800		13,300	
	4A	5,500	20,000			25,500	
Tye River (12-25)		150,000	279,000	180,000	8,300	617,300	50
	3A	75,000	234,000	160,000	6,000	475,000	
	4	50,000	30,000	20,000	1,000	101,000	50
	5	10,000	15,000		1,300	26,300	
	6	15,000				15,000	
Piney River (12-26)		105,000	58,500	86,500	6,500	256,500	40
	1A	35,000	13,500	76,500	3,000	128,000	
	2A	25,000	7,500	10,000	500	43,000	
	3	45,000	37,500		3,000	85,500	40

See footnotes at end of table.

Appendix B. Table 15. Project site easement and relocation cost data for early action watersheds, James River Basin--Continued

Watershed	Site	Pool Area: Easement Costs	Building Relocation	Road Relocation	Utility Relocation	Total	Additional Recreational Development
		Dollars1/					
Hardware River (12-30)		460,000	30,000	98,000	8,300	593,000	99
	1	45,000		5,000		50,000	
	2A	80,000		58,000	2,000	140,000	47
	3	110,000	10,000	20,000	1,500	141,500	
	4	100,000	20,000	15,000	1,500	136,500	52
	5	100,000				100,000	
	6	25,000				25,000	
James River 5 (12-36)		55,000	10,000	5,000		70,000	
	3B	25,000	10,000	5,000		40,000	
	4	30,000				30,000	
Beaver Creek (12-43)		37,000				37,000	
	2	30,000				30,000	
	7	7,000				7,000	
Calfpasture River		171,050	103,500	77,500	4,250	356,300	53
(12a-1)	1	29,000	20,000	20,000	1,500	70,500	53
	2C	40,000	50,000	30,000	1,500	121,500	
	3	15,000				15,000	
	4A	5,000				5,000	
	5A	5,500	20,000	7,500	500	33,500	
	6	14,800	7,000	5,000		26,800	
	7	52,250	5,000	15,000	750	73,000	
	8	9,500	1,500			11,000	
North Fork Rivanna		644,000	125,000	65,000	18,300	852,300	200
(12b-1)	3	125,000	10,000	10,000	15,000	160,000	
(12b-2)	1C	64,000			500	64,500	
(12b-7)	1	100,000	50,000	30,000	800	180,800	
	2	20,000				20,000	
	3	35,000				35,000	
	6A	40,000				40,000	
(12b-12)	11	260,000	65,000	25,000	2,000	352,000	200
Total Early Action Watersheds		2,436,412	869,900	1,389,060	61,250	4,756,622	668

Source: Soil Conservation Service personnel.

1/ Base year 1967.

Appendix B. Table 16. Summary of installation cost allocation for identified needs & full potential development, early action watersheds, James River Basin

Watershed and Structure	Development to Meet Identified Needs: Flood Prevention	Water Supply	Recreation	Total	Full Development Potential: Flood Prevention	Water Supply	Recreation 1/	Addit'l Storage Available	Total
	Thousands of Dollars 2/								
Ogle Creek (12-3)	1,663.3	324.4	0	1,987.7	1,075.6	324.4	0	2,567.6	3,967.6
Site 1	529.4			529.4	320.7			867.1	1,187.8
Site 2	407.8			407.8	203.9			551.4	755.3
Site 3	394.9			394.9	205.4			555.5	760.9
Site 5	205.1			205.1	219.5			593.6	813.1
Site 6	126.1	324.4		450.5	126.1	324.4			450.5
Dunlap Creek (12-4,5)	2,046.[illegible]	332.8	0	2,379.5	1,618.0	340.6	0	4,034.0	5,992.6
Site 1A	[illegible]			[illegible]	170.7			461.7	632.4
Site 2	[illegible]			[illegible]	240.7			650.9	891.6
Site 3A	461.1			[illegible]	258.4			698.8	857.2
Site 4	[illegible]			[illegible]	43.6			117.7	161.3
Site 5	[illegible]	332.9	468.7		[illegible]	340.6		19.7	493.6
Site 1A	[illegible]		769.3		278.5			752.9	1,031.4
Site 2A	[illegible]			[illegible]	492.8			1,332.3	1,825.1
Upper Jackson River (12-6,7)	[illegible]	254.5	1,909.3	[illegible]	[illegible]	157.3	1,805.4	1,965.1	5,702.4
Site 1	[illegible]			[illegible]	213.3			497.8	711.1
Site 1G	[illegible]		1,900.3	2,573.9	601.1		1,805.4	493.8	2,900.3
Site 4	448.1	[illegible]		567.2	307.7	[illegible]		640.0	1,032.3
Site 4	[illegible]	135.4		[illegible]	166.8	[illegible]		333.5	575.0
Channel Improvement	483.7			483.7	483.7				483.7
Cowpasture River (12-12,13,14)	5,932.9	157.7	2,530.3	8,620.9	3,236.6	79.0	[illegible]	[illegible]	[illegible]
Site [illegible]	510.2	[illegible]		614.7	230.3	55.3		[illegible]	912.2
Site [illegible]	1,244.5		2,530.3	3,774.8	1,204.0		2,408.7	[illegible]	[illegible]
Site 1B	1,423.9			1,423.9	548.8			1,561.8	[illegible]
Site 1A	1,516.2			1,516.2	510.8			1,570.5	[illegible]
Site 3	745.1			745.1	415.2			968.7	1,383.9
Site 7L	479.0	53.2		532.2	213.5	23.7		553.6	790.8
Channel Improvement	14.0			14.0	14.0				14.0
[illegible] River (12-[illegible])	2,314.[illegible]	743.2	0	3,057.9	1,578.5	355.1	0	[illegible]	5,442.8
Site [illegible]	[illegible]	489.6		1,440.0	448.7	232.0		806.4	1,547.1
Site 1C	[illegible]			913.5	934.8			[illegible]	3,120.0
Site 4A	[illegible]	253.6		740.4	255.0	124.1		426.6	755.7
[illegible] River (12-[illegible])	[illegible]	106.9	193.8	[illegible]	3,352.5	129.9	176.7	4,854.7	8,513.8
Site [illegible]A	[illegible]	106.9		[illegible]	2,337.9	129.9		4,026.4	6,494.2
Site 4	422.4		193.8	[illegible]	299.9		176.7	470.2	946.8
Site 5	164.3			[illegible]	98.3			167.4	265.7
Site 6	150.2			[illegible]	112.0			190.7	[illegible]
Channel Improvement	504.4			[illegible]	504.4				504.4

See footnotes at end of table.

Appendix B. Table 16. Summary of installation cost allocation for identified needs & full potential development, early action watersheds, James River Basin--Continued

Watershed and Structure	Development to Meet Identified Needs: Flood Prevention	Water Supply	Recreation	Total	Full Development Potential: Flood Prevention	Water Supply	Recreation 1/	Addit'l Storage Available	Total
	Thousands of Dollars 2/								
Piney River (12-26)	2,592.8	169.2	811.7	3,573.7	2,220.4	182.0	811.7	1,933.3	5,147.4
Site 1A	1,405.5			1,405.5	985.1			1,751.2	2,736.3
Site 2A	888.4	169.2		1,057.6	936.4	182.0		182.0	1,300.5
Site 3	298.9		811.7	1,110.6	298.9		811.7		1,110.6
Hardware River (12-30)	1,698.8	115.4	965.6	2,777.8	1,361.5	69.5	965.6	1,166.2	3,562.8
Site 1	261.6			261.6	194.6			317.5	512.1
Site 2A	188.3		742.0	495.5	188.3		742.0		930.3
Site 3	422.2	68.7		490.9	242.6	38.3		357.6	638.5
Site 4	361.2		223.6	584.8	361.2		223.6		584.8
Site 5	287.0	46.7		333.7	197.3	31.2		290.8	519.3
Site 6	121.7			121.7	122.7			200.3	323.0
Channel Improvement	54.8			54.8	54.8				54.8
James River 5 (12-36)	593.1	104.5		697.6	407.0	81.2		634.8	1,123.0
Site 3B	297.3	104.5		401.8	230.2	81.2		365.6	677.0
Site 4	257.7			257.7	138.7			269.2	407.9
Channel Improvement	38.1			38.1	38.1				38.1
Beaver Creek (12-43)	531.5	81.7		613.2	422.4	62.9		745.7	1,231.0
Site 2	273.6	81.7		355.3	214.0	62.9		352.5	629.4
Site 7	252.0			252.0	202.5			393.2	595.7
Channel Improvement	5.9			5.9	5.9				5.9
Calfpasture River (12a-1)	3,930.0	444.1	238.4	4,612.5	2,511.8	234.5	227.9	5,953.5	8,927.7
Site 1	706.1		238.4	944.5	617.8		227.9	1,470.1	2,315.8
Site 2C	1,200.7	444.1		1,644.8	656.7	234.5		1,454.0	2,345.2
Site 3	348.4			348.4	117.0			286.6	403.6
Site 4A	390.3			390.3	272.9			668.2	941.1
Site 5A	244.6			244.6	237.0			580.2	817.2
Site 6	195.7			195.7	112.8			267.1	388.9
Site 7	208.2			208.2	157.6			385.8	543.4
Site 8	636.0			636.0	340.0			832.5	1,172.5
North Fork Rivanna River (12b-1,2,7,12)	3,055.9	231.2	1,269.0	4,556.1	3,030.1	224.7	1,406.2	3,730.8	8,391.8
Site 3	682.9	43.6		726.5	676.7	35.6		1,068.1	1,780.4
Site 1C	283.0			283.0	197.1			283.5	480.6
Site 1	437.7	187.6		625.3	420.2	189.1		441.2	1,050.5
Site 2	120.1			120.1	111.1			159.8	270.9
Site 3	195.7			195.7	186.3			268.2	454.5
Site 6A	266.8			266.8	253.2			365.2	618.9
Site 11	786.7		1,269.0	2,055.7	987.9		1,406.2	861.3	3,255.4
Total Early Action Watersheds	30,394.0	3,065.9	7,909.1	41,369.0	22,589.0	2,242.1	7,802.2	38,282.5	70,915.8

1/ This cost includes cost of access roads, tables, boat ramps, camping sites, water supply, and sewerage facilities.
Source: Watershed Investigation Reports, SCS . 2/ Base year 1967.

Appendix B. Table 17. Water storage for identified needs & full potential development, early action watersheds, James River Basin, 1967

Watershed and Structure	Development to Meet Identified Needs: Flood Prevention	Water Supply	Recreation	Total	Full Development Potential: Flood Prevention	Water Supply	Recreation	Addit'l Storage Available	Total
	Acre-Feet								
Ogle Creek (12-3)	5,385	1,000		6,385	5,385	1,000		13,230	19,615
Site 1	2,480			2,480	2,480			6,570	9,050
Site 2	885			885	885			2,340	3,225
Site 3	630			630	630			1,665	2,295
Site 5	1,005			1,005	1,005			2,655	3,660
Site 6	385	1,000		1,385	385	1,000			1,385
Dunlap Creek (12-4,5)	9,515	3,150		12,665	9,515	3,150		22,105	34,770
Site 1A	1,010			1,010	1,010			2,690	3,700
Site 2	730			730	730			1,940	2,670
Site 3A	1,555			1,555	1,555			4,125	5,680
Site 4	420			420	420			1,110	1,530
Site 5	1,260	3,150		4,410	1,260	3,150		190	4,600
Site 1A	1,740			1,740	1,740			4,625	6,365
Site 2A	2,800			2,800	2,800			7,425	10,225
Upper Jackson River (12-6,7)	13,775	1,000	15,835	30,610	13,775	1,000	15,835	16,955	47,565
Site 1	1,635			1,635	1,635			3,680	5,315
Site 1G	9,165		15,835	25,000	9,165		15,835	7,130	32,130
Site 4	1,910	500		2,410	1,910	500		4,020	6,430
Site 4	1,065	500		1,565	1,065	500		2,125	3,690
Cowpasture River (12-12,13,14)	35,720	1,000	14,195	50,915	35,720	1,000	14,195	84,080	134,995
Site 1A	2,400	500		2,900	2,400	500		6,660	9,560
Site 1B	10,805		14,195	25,000	10,805		14,195	17,120	42,120
Site 1B	10,925			10,925				30,775	41,700
Site 1A	5,330			5,330	5,330			13,665	18,995
Site 3	1,525			1,525	1,525			3,720	5,245
Site 7B	4,735	500		5,235	4,735	500		12,140	17,375
Jackson River 5 (12-15)	8,115	3,000		11,115	8,115	3,000		16,920	28,035
Site 1B	2,905	1,500		4,405	2,905	1,500		5,605	10,010
Site 1C	2,590			2,590	2,590			6,265	8,855
Site 4A	2,620	1,500		4,120	2,620	1,500		5,050	9.170
Tye River (12-25)	16,916	500	500	17,916	16,916	500	500	28,985	46,901
Site 3A	11,815	500		12,315	11,815	500		20,680	32,995
Site 4	3,535		500	4,035	3,535		500	5,645	9,680
Site 5	580			580	580			980	1,560
Site 6	990			990	990			1,680	2,670
Piney River (12-26)	10,475	500	3,865	14,840	10,475	500	3,865	10,530	23,370
Site 1A	5,620			5,620	5,620			10,020	15,640
Site 2A	2,585	500		3,085	2,585	500		510	3,595
Site 3	2,270		3,865	6,135	2,270		3,865		6,135

Appendix B. Table 17. Water storage for identified needs & full potential development, early action watersheds, James River Basin, 1967--Continued

Watershed and Structure	Development to Meet Identified Needs				Full Development Potential				
	Flood Prevention	Water Supply	Recreation	Total	Flood Prevention	Water Supply	Recreation	Addit'l Storage Available	Total
	Acre-Feet								
Hardware River (12-30)	14,560	1,060	3,935	19,555	14,560	1,060	3,935	12,995	32,550
Site 1	1,275			1,275	1,275			2,065	3,340
Site 2A	2,050		3,315	5,365	2,050		3,315		5,365
Site 3	3,460	560		4,020	3,460	560		5,030	9,050
Site 4	3,815		620	4,435	3,815		620		4,435
Site 5	3,125	500		3,625	3,125	500		4,545	8,170
Site 6	835			835	835			1,355	2,190
James River 5 (12-36)	3,060	500		3,560	3,060	500		5,350	8,910
Site 3B	1,395	500		1,895	1,395	500		2,175	4,070
Site 4	1,665			1,665	1,665			3,175	4,840
Beaver Creek (12-43)	2,585	500		3,085	2,585	500		4,450	7,535
Site 2	1,695	500		2,195	1,695	500		2,750	4,945
Site 7	890			890	890			1,700	2,590
Calfpasture River (12a-1)	13,095	1,500	205	14,800	13,095	1,500	205	30,895	45,695
Site 1	2,530		205	2,530	2,530		205	5,960	8,695
Site 2C	4,005	1,500		5,505	4,005	1,500		8,930	14,435
Site 3	395			395	395			955	1,350
Site 4A	950			950	950			2,290	3,240
Site 5A	685			685	685			1,650	2,335
Site 6	575			575	575			1,375	1,950
Site 7	2,925			2,925	2,925			7,265	10,190
Site 8	1,030			1,030	1,030			2,470	3,500
North Fork Rivanna River (12b-1,2,7,12)	36,915	2,595	10,250	49,760	36,915	2,595	10,250	44,080	93,840
Site 3	7,575	500		8,075	7,575	500		12,000	20,075
Site 1C	4,620			4,620	4,620			6,590	11,210
Site 1	4,645	2,095		6,740	4,645	2,095		4,885	22,835
Site 2	905			905	905			1,320	2,225
Site 3	1,915			1,915	1,915			2,775	4,690
Site 6A	2,505			2,505	2,505			3,630	6,135
Site 11	14,750		10,250	25,000	14,750		10,250	12,880	37,880
Total Early Action Watersheds	170,116	15,805	48,785	234,706	170,116	15,805	48,785	290,575	525,281

Source: Watershed Investigation Reports.

Appendix B. Table 18. Derivation of Benefit-Cost ratio, early action watersheds, James River Basin, 1967

Watershed	Average Annual Benefits: Flood Prevention	Water Supply	Recreation	Redevelopment & Sec. 1/	Total 2/	Average Annual Costs: Installation 5-3/8%	Installation 5-7/8%	Installation 7%	Operation & Maintenance	Total 5-3/8%	Total 5-7/8%	Total 7%	Benefit-Cost Ratio 5-3/8%	5-7/8%	7%
	Thousands of Dollars														
Subarea 1	965.0	95.2	520.1	399.2	1,979.5	1,326.0	1,446.5	1,729.6	168.6	1,494.6	1,615.1	1,898.2	1.3:1	1.2:1	1.0:1
Ogle Creek (12-3)	94.1	17.0	0	33.2	144.3	107.4	117.2	139.3	1.5	108.9	118.7	140.8	1.3:1	1.2:1	1.0:1
Dunlap Creek (12-4,5)	86.8	17.0	0	38.7	142.5	128.6	140.3	166.8	3.5	132.1	143.8	170.3	1.0:1	0.9:1	0.8:1
Upper Jackson (12-,6,7)	135.5	12.0	235.3	91.6	474.4	236.8	258.4	307.2	71.2	308.0	329.6	378.3	1.5:1	1.4:1	1.3:1
Cowpasture River (12-12,13,14)	359.1	8.4	252.6	163.2	783.3	465.9	308.2	604.2	75.5	541.4	583.7	679.7	1.4:1	1.3:1	1.2:1
Jackson River (12-15)	111.2	35.8	0	51.0	198.0	165.2	180.3	214.3	4.0	169.2	184.3	218.3	1.2:1	1.1:1	0.9:1
Tye River (12-25)	178.3	5.0	32.2	21.5	237.0	222.0	242.2	298.0	12.8	234.9	255.1	310.8	1.1:1	0.9:1	0.8:1
Subarea 2	617.9	58.6	450.1	112.5	1,239.1	894.2	974.7	1,159.7	159.9	1,054.1	1,134.6	1,319.6	1.2:1	1.1:1	0.9:1
Piney River (12-26)	135.8	8.4	74.4	21.8	240.4	193.1	210.7	250.4	26.7	219.8	237.3	277.1	1.1:1	1.0:1	0.9:1
Hardware River (12-30)	87.0	6.4	166.8	26.0	286.2	150.1	163.8	194.7	51.8	201.9	215.5	246.4	1.4:1	1.3:1	1.2:1
James River 5 (12-36)	54.4	5.4	0	5.9	65.7	37.7	41.1	48.9	2.0	39.7	43.1	50.9	1.7:1	1.5:1	1.3:1
Beaver Creek (12-43)	31.5	4.3	0	3.6	39.4	33.1	36.2	43.0	1.5	34.6	37.6	44.5	1.1:1	1.0:1	0.9:1
Calfpasture Ri. (12a-1)	183.6	21.8	31.8	23.7	260.9	249.3	271.1	323.2	15.1	264.4	287.0	338.4	1.0:1	0.9:1	0.8:1
North Fork Rivanna River (12b-1,2,7,12)	125.6	12.3	177.1	31.5	346.5	230.9	251.9	299.5	62.8	293.8	314.7	362.3	1.2:1	1.1:1	1.0:1
Total Early Action Watersheds	1,582.9	153.8	970.2	511.7	3,218.6	2,220.3	2,421.2	2,889.3	328.4	2,548.7	2,749.7	3,217.7	1.3:1	1.2:1	1.0:1

1/ Definitions of these terms are in the text, Chapter 9.

2/ For total benefits or difference for varying interest rates, the differences are too minor to warrant extra columns on this table.

Source: Watershed Investigation Reports, SCS.

Appendix B. Table 19. Summary of economic activity destroyed or displaced by watershed development, early action watersheds, James River Basin, 1967

Watershed and Site	Land Inundated		Buildings Displaced		Estimated Value Destroyed			
	Open	Forest	Residences	Other	Land and Buildings	Annual Agriculture	Standing Timber	Annual Timber
	Acres		Number		Dollars			
Ogle Creek (12-3)	88	118	8	4	13,816	4,854	4,140	1,180
Site 1	50	4	4	1Church	7,850	2,760	190	40
Site 2	5	30	3	2	785	275	1,430	300
Site 3	0	17					810	170
Site 5	23	0	1	1	3,611	1,269		
Site 6	10	36			1,570	560	1,710	360
Dunlap Creek (12-4,5)	50	283	2	1	7,850	2,760	13,470	2,830
Site 1A	0	27					1,290	270
Site 2	0	24					1,140	240
Site 3A	25	25	1		3,925	1,380	1,190	250
Site 4	0	35					1,670	350
Site 5	25	92		1	3,925	1,380	4,380	920
Site 1A	0	32	1				1,520	320
Site 2A	0	48					2,280	480
Upper Jackson River (12-6,7)	430	163	6	3	60,200	34,400	27,710	1,630
Site 1	0	70	1	1			11,900	700
Site 1G	330	25	3	2	46,200	26,400	4,250	250
Site 4	100	8	1		14,000	8,000	1,360	80
Site 4	0	60	1				10,200	600
Cowpasture River (12-12,13, 14)	950	329	11	12	133,000	76,000	55,930	3,290
Site 1A	140	1	1	1	19,600	11,200	170	10
Site 1B	460	25	2	2	64,400	36,800	4,250	250
Site 1B	190	66	6	6	26,600	15,200	11,220	660
Site 1A	0	120					20,400	1,200
Site 3	50	12		1	7,000	4,000	2,040	120
Site 7B	110	105	2	2	15,400	8,800	17,850	1,050
Jackson River 5 (12-15)	55	259	23	1	8,635	3,030	12,950	2,590
Site 1B	20	100	7	1	3,140	1,100	5,000	1,000
Site 1C	35	80	16		5,495	1,930	4,000	800
Site 4A	0	79					3,950	790
Tye River (12-25)	250	246	28	11	42,000	23,240	29,250	2,460
Site 3A	65	160	18	7	10,920	6,040	19,020	1,600
Site 4	150	21	5	2	25,200	13,950	2,500	210
Site 5	20	10	5	2	3,360	1,860	1,190	100
Site 6	15	55			2,520	1,390	6,540	550
Piney River (12-26)	225	103	10	11	34,875	16,875	10,810	1,030
Site 1A	35	90	7	6	5,425	2,625	9,450	900
Site 2A	75	11	1	3	11,625	5,625	1,150	110
Site 3	115	2	2	2	17,825	8,625	210	20

Appendix B. Table 19. Summary of economic activity destroyed or displaced by watershed development, early action watersheds, James River Basin, 1967--Continued

Watershed and Site	Land Inundated		Buildings Displaced		Estimated Value Destroyed			
	Open	Forest	Residences	Other	Land and Buildings	Annual Agriculture	Standing Timber	Annual Timber
	Acres		Number		Dollars			
Hardware River (12-30)	850	140	1	1	334,900	82,740	19,600	1,400
Site 1	85	1	1	1	33,490	8,275	140	10
Site 2A	165	3			65,010	16,060	420	30
Site 3	215	3			84,710	20,930	420	30
Site 4	140	92			55,160	13,625	12,880	920
Site 5	195	25			76,830	18,980	3,500	250
Site 6	50	16			19,700	4,870	2,240	160
James River 5 (12-36)	55	129	2	1	8,305	4,125	12,250	1,290
Site 3B	45	29		1	6,795	3,375	2,750	290
Site 4	10	100	2		1,510	750	9,500	1,000
Beaver Creek (12-43)	125	29	1	2	20,875	11,880	3,160	290
Site 2	95	17			15,865	9,030	1,850	170
Site 7	30	12	1	2	5,010	2,850	1,310	120
Calfpasture River (12a-1)	280	253	19	14	78,400	48,610	34,140	2,530
Site 1	45	99	5	4	12,600	7,810	13,360	990
Site 2C	150	46	5	2	42,000	26,050	6,210	460
Site 3	0	19					2,560	190
Site 4A	30	8	1		8,400	5,210	1,080	80
Site 5A	15	20	6	2	4,200	2,600	2,700	200
Site 6	15	18	2	2	4,200	2,600	2,430	180
Site 7	15	18		1	4,200	2,600	2,430	180
Site 8	10	25		3	2,800	1,740	3,370	250
North Fork Rivanna River (12b-1,2,7,12)	1,523	708	10	14	441,670	155,346	104,070	7,080
Site 3	375	45	1	4	108,750	38,250	6,610	450
Site 1C	203	87			58,870	20,706	12,790	870
Site 1	260	70	5	5	75,400	26,520	10,290	700
Site 2	65	9	1	3	18,850	6,630	1,320	90
Site 3	5	113			1,450	510	16,610	1,130
Site 6A	15	126			4,350	1,530	18,520	1,260
Site 11	600	258	3	2	174,000	61,200	37,930	2,580
Total Early Action Watersheds	4,881	2,760	121	75	1,184,526	463,860	327,480	27,600

Source: USGS topographic maps, aerial photographs and Appendix tables.

Appendix B. Table 20. Summary of development levels & economic impacts, early action watersheds, James River Basin, 1967

	Land Required	Installation Costs	Economic Activity: Destroyed	Economic Activity: Generated by Use Conversion Activities	Economic Activity: Generated by Annual Operations	Economic Activity: Other Annual Benefits	Other Impacts 2/
	Acres	Dollars					
Ogle Creek (12-3)							
Identified Needs	203	1,987,700	12,160	3,975,400	39,400	252,100	
Full Potentials	392	3,967,600	23,360	7,935,200	39,400	252,100	
Dunlap Creek (12-4,5)							
Identified Needs	333	2,379,500	11,180	2,559,000	45,000	246,800	
Full Potential	634	5,992,500	21,260	11,765,000	45,000	246,800	
Upper Jackson River (12-6,7)							
Identified Needs	862	3,629,500	72,060	7,259,000	142,500	450,900	
Full Potential	1,334	4,949,000	111,440	9,898,000	142,500	450,900	
Adjacent Recreational Areas	96	753,400	1,600	1,506,800	497,700	1/	
Cowpasture River (12-12,13,14)							
Identified Needs	1,467	7,740,300	158,580	15,480,600	148,100	1,035,700	
Full Potential	3,220	12,032,300	348,040	24,064,600	148,100	1,035,700	
Adjacent Recreational Areas	130	348,040	2,100	1,761,200	533,740	1/	
Jackson River 5 (12-15)							
Identified Needs	314	3,057,900	11,240	6,113,200	83,900	319,800	
Full Potential	538	5,442,800	19,260	10,885,600	83,900	319,800	
Tye River (12-25)							
Identified Needs	496	3,972,700	51,400	7,945,400	33,600	397,400	
Full Potential	999	8,377,600	103,438	16,775,200	33,600	397,400	
Adjacent Recreational Areas	50	136,200	900	272,400	68,000	1/	
Piney River (12-26)							
Identified Needs	405	3,249,800	35,810	6,499,600	61,800	313,300	
Full Potential	504	4,823,500	44,400	9,647,000	61,800	313,300	
Adjacent Recreational Areas	40	323,900	600	647,800	159,000	1/	
Hardware River (12-30)							
Identified Needs	1,079	2,178,200	168,280	4,356,400	100,600	222,100	
Full Potential	1,701	2,963,200	265,292	5,926,400	100,600	222,100	
Adjacent Recreational Areas	99	265,292	1,900	1,199,200	353,300	1/	
James River 5 (12-36)							
Identified Needs	189	697,600	10,830	1,395,200	17,700	117,800	
Full Potential	405	1,123,000	23,214	2,246,000	17,700	117,800	
Beaver Creek (12-43)							
Identified Needs	154	613,200	23,340	1,225,200	14,700	67,200	
Full Potential	295	1,231,000	46,578	2,462,000	14,700	67,200	

See footnotes at end of table.

Appendix B. Table 20. Summary of development levels & economic impacts, early action watersheds, James River Basin, 1967--Continued

	Land Required	Installation Costs	Destroyed	Economic Activity: Generated by Use Conversion Activities	Economic Activity: Generated by Annual Operations	Economic Activity: Other Annual Benefits	Other Impacts 2/
	Acres	Dollars					
Calfpasture River (12a-1)							
Identified Needs	835	4,427,200	101,380	8,854,400	77,700	407,100	
Full Potential	1,611	8,742,400	197,312	17,484,800	77,700	407,100	
Adjacent Recreational Areas	53	185,300	1,700	370,600	67,200	1/	
North Fork Rivanna River (12b-1,2,7,12)							
Identified Needs	2,231	3,550,800	324,852	7,101,600	128,100	311,900	
Full Potential	3,741	7,911,200	536,000	14,377,800	128,100	311,900	
Adjacent Recreational Areas	200	722,300	4,000	1,444,600	378,500	1/	
Total Early Action Watersheds							
Identified Needs	8,568	37,484,400	982,112	72,765,000	893,100	4,142,100	
Full Potential	15,374	67,556,100	1,739,594	133,467,600	893,100	4,142,100	
Adjacent Recreational Areas	668	3,601,300	12,800	7,202,600	2,057,440	1/	

1/ Changed use and redevelopment resulting from development of adjacent recreational areas were not computed.

2/ Dollar values of other impacts can be added in this column as they become known.

Source: Watershed Investiga ion Reports, SCS.

Appendix B. Table 21. Early action watersheds including recreation as a project purpose, James River Basin

Watershed	Recreation Subarea	Site	Acreage		Est. Ann. Rec. Days 1/	
			Land	Water	Initial	Ultimate
Upper Jackson River (12-6,7)	1	12-6 (1G)	390	489	78,000	117,600
Cowpasture River (12-12,13,14)	1	12-12 (1B) 2/	420	526	84,000	210,400
Tye River (12-25)	2	4	50	62	24,800	24,800
Piney River (12-26)	2	3	110	143	57,200	57,200
Hardware River (12-30)	2	2A	200	134	80,000	80,000
Calfpasture River (12a-1)	1	6	53	53	21,200	21,200
North Fork Rivanna River (12-1,2,7,12)	3	12b-12(11)	332	416	74,900	166,400
Total		7	1,555	1,823	420,100	677,600

1/ Annual recreation days based on optimum project storage. A recreation day is a standard measure of use consisting of a visit by one person to an outdoor development or area to engage in one or more recreation activities during all or part of a day.

2/ Project is in conflict with Bullpasture River proposed for inclusion into the Virginia Scenic River System. Other impoundments in conflict include structure 12-13 (1B) on Cowpasture River.

Source: Bureau of Outdoor Recreation.

APPENDIX C

This appendix utilizes the basic economic data in Appendix B to summarize the economic effects of the 12 early action projects. Most of the field data was compiled from investigations made prior to 1970. Cost of structural measures were based on the levels of development required to meet identified needs estimated from the best data available at the time evaluations were made. Flood prevention objectives would provide protection from the 5-year frequency flood insofar as practical and feasible. Prior to implementation changes in these values and conditions will probably require reevaluation of individual projects. However, much of the data presented can be used or easily modified to make the needed adjustments.

Economic Impacts of Early Action Watershed Projects

The planning effort by the USDA team (SCS, FS, and ERS) has resulted in the selection of many feasible reservoir development sites in the watersheds of the James River Basin. This multitude of potentially feasible watershed development opportunities has been divided into three groups. The first group has been classified as "early action" and contains those watersheds where the problems are serious enough for recommended development before 1980. Group two has problems which are less serious and therefore, development is recommended to occur between 1980 and 2000. The problems of the third group are clearly not of a critical nature and therefore, development is recommended to occur between 2000 and 2020.

The discussion of impacts presented here will concern itself with the early action watersheds. Development of these projects is of immediate concern to local officials for use in solving current problems. Also, development of the watersheds before 1980 means that current cost estimates and impact evaluations will not change substantially. Costs and impacts are not presented for the last two groups of watersheds (1980-2020) because of probable changes which will necessitate a later re-examination.

There are 12 watersheds recommended for development before 1980. Six are in Subarea 1 and six in Subarea 2 as described in the Economic Base Report published earlier by ERS. They are all in the mountainous western part of the Basin or in the foothills immediately to the east. They are all above Richmond.

The following discussion assumes that the recommended watershed projects will be carried through to completion, i.e. land rights obtained, relocations occur, and construction completed. The dams which are proposed will be used as flood control structures. In addition, some of the structures are recommended to include storage for water supply and recreational purposes. If additional storage for water supply or recreation is planned for a structure, arrangements must be made for cost sharing. The complexity of cost sharing in the acquisition and development process is briefly described in the following paragraphs.

Land inundated by a flood control structure does not have to be purchased by the local Flood Control District, although landowners at the project site may either grant easements or sell the land inundated by the flood pool.[1/] If the land rights are in the form of easements, the farmer may utilize, at his own risk, the land above the normal pool.[2/] No structures may be placed on this land.[3/] Access must also be secured for the purposes of structural operation and maintenance, and is usually granted without a monetary cost.

If the site is not purchased, ownership of the land does not change and the landowner can charge access fees for fishing or other recreational purposes. However, property taxes might increase based on the improved value imputed to downstream land as a result of increased flood protection. This depends on assessment policies.

If a structure is used for water supply storage, the land which the pool will inundate is usually purchased. Thus, a farmer may not utilize land below the flood pool boundaries. Access must be secured for operation and maintenance of the structure. There is also no bathing or power motors allowed in water supply reservoirs because pollution and disease may occur.

1/ The flood pool is the maximum pool which can be formed behind a dam before water begins to flow over the emergency spillway. The spillway height is usually a short distance below the top of the dam.

2/ The normal pool is the area designed for sediment accumulation. It is usually much smaller in area than the flood pool.

3/ Agricultural production losses will refer to losses resulting from the land in the flood pool being taken out of production. Although this assessment may overestimate annual losses, one must realize that the land between the normal pool boundary and the flood pool boundary is subject to frequent inundation.

The land area of a structure utilized for recreational purposes is always purchased. The purchasing authority must also purchase land up to a maximum of 100 feet horizontally or five feet vertically back from the boundaries of the flood pool. This area cannot be farmed and public access must be purchased from the landowner. A single structure will not be utilized both as a source of water supply and for extensive water based recreation (i.e. power boating, swimming) because of the aforementioned pollution problems. The preceding paragraphs only briefly outline the problems involved in developing a multipurpose project. The procedure used to develop the project will affect the measurement of impacts resulting from development.

Summary of Total Impacts

Description of Data in Appendix Tables. The following watershed impact reports utilize two sets of tables. The first set of tables are found in the appendix (Appendix B, Tables 12 through 21) and were placed there because they summarize data for all 12 watersheds and could not efficiently appear as part of the discussion for each watershed. The second set or tables consists of two tables for each watershed. These two tables relate specifically to the watershed and therefore appear with the discussion for each watershed.

Appendix B, Table 12 presents site and drainage area data as well as flood plain land use and damage data for each watershed. There are 29 sites recommended for Subarea 1 and 28 sites for Subarea 2 for a total of 57 sites. The total area drained by these 12 watersheds is 1,102,060 acres or 17 percent of the James River Basin. The 57 recommended sites will partially control 433,920 acres or 39 percent of the total area drained by the 12 watersheds. There are 55,055 acres classified by SCS as in the flood plain of which 42,960 acres are in cropland and pasture which represent 78 percent of the total. Forested acres account for another 13 percent of the flood plain and urban and other land comprise the remaining 9 percent. Urban flood damage is 62 percent of the total annual flood damages, although comprising only 9 percent of flood plain. Agricultural damages are 12 percent of total annual damages. The remaining 26 percent of flood damages are road, bridge, and indirect damages.

Appendix B, Table 13 summarizes watershed and county agricultural data. Acres and percentages are given which determine the importance of the watershed and of agricultural land in the county. Average size and value figures are also shown for each county. These average values are used later to determine the value and relative importance of agricultural land inundated by each watershed development structure.

Appendix B, Table 14 summarizes structural and land treatment data for the early action watersheds. Easements and/or ownership must be obtained for 8,568 acres of land. More acreage will be required if borrow pits and maintenance access must be obtained.

Additional recreational development will necessitate purchase of more land. The 12 watershed development projects studied would provide 170,129 acre-feet of storage for flood control purposes, 16,305 acre-feet of water supply storage and 48,785 acre-feet of storage for recreational purposes. There is 296,125 acre-feet of additional storage available if all the sites are developed to their maximum potential. Channel improvement is recommended for 42 miles of stream. Land treatment measures are recommended for 107,230 acres of cropland and pasture and for 82,700 acres of forest land and other land. Although there is only one more site recommended for Subarea 1 than for Subarea 2 - 29 vs. 28 - the total storage available is 42 percent greater than in Subarea 2, indicating that the average site in Subarea 1 contains more storage capacity. However, average normal pool surface area per site is 14 percent larger in Subarea 2. These observations indicate deeper, smaller pools in Subarea 1, which is compatible with the observed differences in topography.

Appendix B, Table 15 summarizes easement and relocation costs for the early action watersheds. Easement costs for the twelve watersheds total $2,436,412 and relocation costs are $4,756,622. In addition, recreational development is recommended for 668 acres of land adjacent to flood pool areas.

Appendix B, Table 16 compares the cost allocation for development purposes (flood prevention, water supply, and recreation) for the two alternative levels of development. USDA planners recommend development to meet the immediate identified needs of the people in and adjacent to the watersheds. Full potential development is the maximum level of development possible at a site. The higher level of development causes minor shifts in cost allocations and creates a large amount of additional storage available. This additional storage can be used for water supply, recreation, or other purposes if the additional cost is paid by a participating Federal, State, or local agency.

The cost allocated to flood prevention at the lower level of development for the 12 watersheds is $30,394,040. If all the sites are developed to their fullest potential this cost decreases to $22,589,040.1/ Total costs at the lower level of development are $41,369,000 and if all the sites are fully developed this cost almost doubles to $70,915,800. Recreation is the most likely use of the additional storage available but the additional development would more than quadruple recreation's share of the development cost.

1/ The flood prevention portion of the cost decreases because of economies of scale realized in the construction of a larger dam. Costs of construction are computed per acre-foot of storage for each level of development with the result that the cost per acre-foot of storage at the higher level of development is less than at the lower level and therefore the cost for the fixed amount of flood prevention storage is less at the upper level of development.

The costs of developing a watershed must be paid by someone. Constraints have been set by law which limit the participation by each level of government in developing a watershed. The costs of flood control are shared in the following manner: the SCS (using PL-566 funds) pays all construction and engineering costs and local[1/] agencies pay for all land acquisition (or easements) and annual operation and maintenance. Relocation costs are shared by both Federal and local levels of government. The costs of providing water supply storage are paid completely by local agencies (usually the town for which the water supply storage is provided). However, the provisions of the Rural Development Act of 1972 might permit SCS to cost share for water supply storage.[2/] The costs of recreation storage can be paid in the following manner: the SCS will pay for all engineering costs, and up to 50 percent of the construction, land and relocation costs. Local agencies pay for the rest including all operation and maintenance costs.

Appendix B, Table 17 presents a summary of water by type for each early action site. The totals for each watershed are summarized in Appendix B, Table 14 as well as in this table. The information in this table is combined with the allocation data in Appendix B, Table 16 to determine the development cost per acre-foot of water storage which is presented and discussed later in this section.

Appendix B, Table 18 presents the benefit-cost (B-C) ratio and the data necessary to compute it for each of the watersheds, for Subareas 1 and 2, and for all 12 watershed development projects combined. The B-C ratios are presented for three alternative interest rates to avoid recomputation each time the official rate changes.

The official rate at the time of this analysis was 5½ percent but was subject to change. The rate for many years was tied to the long term borrowing rate which the Federal government faced (3 to 4 percent). But the decision was made to tie the rate more closely to the long term borrowing rate of the private sector (approximately 6 percent). But the rate, in moving from the lower to the higher rate, could not change more than ¼ percent per annum. Therefore, the rate has been rising for several years and is now approaching the upper rate range. But, there is now another factor which must be considered. The Water Resources Council (WRC) has recently set the official discount rate at 7 percent in its proposed Multiobjective Planning Guidelines and as soon as the President signs the legislation, the 7 percent rate will be the official rate for the next five years. At the end of five years, the WRC will review the rate and make any

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1/ The term local agencies as used here means any agency at a governmental level below the Federal level, i.e. local may mean state, county, city, town or any intermediate level.

2/ For instance, if a community qualifies for Federal assistance under the Rural Development Act, SCS can, as a Federal agency, provide cost-sharing funds.

necessary recommendations for change. Thus, one can see the need for using a range of interest rates when computing B-C ratios for watershed projects.

The data necessary to compute B-C ratios obviously includes benefits and costs. In Appendix B, Table 18 average annual benefits are presented and broken down into flood prevention, water supply, recreation, and redevelopment and secondary benefits. The flood prevention benefits include the increased value of production resulting from increased sales of agricultural products from protected downstream flood plain acres. The increased value of this production can be used to offset losses of agricultural sales resulting from inundation of productive acres. The data needed to make a detailed analysis of this trade-off for each watershed is not available. One needs to know exactly how much agricultural land there is in the downstream flood plains, what portion of it is protected by development of the watershed, and the length of time this situation will exist.

Appendix B, Table 18 also presents, for each watershed, discounted annual costs, operation and maintenance costs, and discounted total costs. Total average annual benefits are divided by discounted average annual total costs to compute the B-C ratios described earlier. The B-C ratio for Subarea 1 is 1.0:1 at the 7 percent interest figure. The B-C ratios for the six individual watersheds range from 0.8:1 to 1.3:1. The B-C ratio for Subarea 2 is 0.9:1, also with a range for the six watersheds from 0.8:1 to 1.3:1. The B-C ratio for the total 12 early action watersheds is 1.0:1. Using an interest rate of 5-3/8 percent increases the total early action watershed B-C ratio to 1.3:1.

Appendix B, Table 19 presents miscellaneous data necessary to determine the impacts of development programs on surrounding areas. There will be 4,881 acres of open land and 2,760 acres of forest land inundated by the proposed 57 structures. There will be approximately 121 residences and 75 other buildings displaced. The estimated value of agricultural land and buildings inundated is $1,184,526. In addition, annual production capacity for agricultural sales of $463,860 will be lost or relocated elsewhere in the Basin. The estimated value of timber products which must be marketed before inundation is $327,480.1/ It is also estimated that an annual productive capacity for forest products of $10 per acre, or $27,600 will be lost.

How complete the loss of inundated agricultural land is to a region depends upon many factors. If only part of a farmer's land is taken, he is not likely to move and only the reduction in activity

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1/ It is assumed that the purchase price of the land in the flood pool includes the value of the standing timber. This timber thus becomes the property of the purchasing authority.

is lost. If the farmer is forced to relocate, and does so by replacing some other farmer, the activity is still lost. About the only way, in fact, that agricultural sales are not reduced is if the farmer establishes as productive agricultural land an area which was not previously used for that purpose and which was not used to support some other form of economic activity. In most cases it is safe to assume that inundated agricultural land will result in a net loss of agricultural sales. However, increased production on downstream agricultural lands resulting from increased flood protection must also be considered. Annual agricultural flood losses are reduced or eliminated thereby increasing the volume of agricultural sales. Business and service industries cannot be treated in this manner since they consume land as a location factor, not as a productive factor.

Appendix B, Table 20 summarizes the tables used later to present development levels and impacts for each watershed. Development of the 12 watersheds to meet identified needs will require 8,568 acres of land and $37,484,400. There will be a reduction in economic activity of $982,112, most of which is the result of (1) loss of production from land necessary for project development, (2) disruptions resulting from construction of structures and services, and (3) multiplier effects of these activities. Annual operations will generate $893,100 of economic activity, which includes activity generated by operation and maintenance, recreation, water supply, and multiplier effects. Other annual benefits will generate $4,142,100 of economic activity. This activity includes damage reduction, changed land use and redevelopment, local secondary, and multiplier effects.

A multiplier[1/] of 2.0 was used when summing the impacts of economic activity. Results using multipliers of 0.5 and 1.5 are available in the tables accompanying each watershed discussion. A range of multipliers is used because the magnitude of a multiplier can vary from region to region, depending on leakages and types of expenditure. Local planners are better able to specify the correct multiplier to use when making the final evaluation.

1/ When money is spent in a region to complete a watershed development project, it is received by workers and residents in the region. These workers and residents respend most of this money in the business and service establishments of the community. These establishments pay wages and buy other goods and services, thus respending part of the original watershed development money. The latter set of wage earners and establishments again spend part of the money, etc. The amount of money spent depends upon (1) the savings propensity of the people and (2) the amount of spending outside the region (leakage). Therefore, depending on local conditions, the money which was originally spent once gets respent two or three more times before the round-by-round impacts become too small to measure.

Multiplier effects can be felt in physical terms as well as in monetary terms. Workers must be hired to construct the structures. These workers may be local or imported. But while they are in the region they must be supplied with goods and services. This in turn may mean additional short term employment opportunities in the region.

Planners must also keep in mind that multipliers can work in reverse. That is, the agriculture which is displaced by a watershed development program can no longer supply products for cash sales. Since this money cannot be spent as it was in the past, there can be no secondary or round-by-round effects. Therefore, the multiplier must also be applied to cash transactions which are lost because of the development. The same reasoning applies for the physical multiplier effects such as jobs. If enough economic activity is displaced it could mean loss of jobs in supporting service industries.

Appendix B, Table 21 presents estimates of the amount of outdoor recreation demand satisfied by the seven watersheds which are recommended to include recreation as a multiple purpose. Development of the sites listed will provide opportunity for 420,100 recreation days of activity in 1980 and for 677,600 recreation days by 2020.

The Bureau of Outdoor Recreation's (BOR) report estimates the outdoor recreation demand and supply in 1980. The three BOR upstream recreation subareas indicate a large supply deficit. The BOR Richmond Subarea (3) shows a huge deficit because of the concentration of population in the subarea. Small watershed impoundments supply a small, but significant, part of the total demand in each BOR subarea: 245 days or 11 percent in BOR Subarea 1, 162 days or 2 percent in BOR Subarea 2, and 75 days or ½ percent in BOR Subarea 3. When computing the supply of recreation days from small watershed impoundments, BOR did not include incidental recreation supplied by upstream reservoirs less than 200 acres in size. Therefore, they slightly underestimate the supply available in 1980 and overestimate the recreation needs deficit. But the underestimation of supply is not large, especially in relation to the large deficit in BOR Subarea 3. Additional outdoor recreational facilities are urgently needed in the upper James River Basin.

Various studies have been made to determine multipliers for recreational expenditures. One such study was for Sullivan County, Pennsylvania, which is a rural county adjacent to the Pocono Mountains resort area of Pennsylvania.[1/] For every dollar spent by recreationists in this county, the total economic activity generated was found to be $1.56 for hunters and fishermen, $1.50 for tourists and $1.62

1/ Gamble, Hays B., "Community Income from Outdoor Recreation", paper presented to the Maryland Governor Recreation Conference, Ocean City, Maryland, 1965.

for summer homeowners. By type of expenditure, the multipliers were \$1.31 for gas station sales, \$1.93 for food and beverages and \$2.19 for local taxes of hunting camps and summer homeowners. A similar study of Clinton County, Pennsylvania,[1/] showed a multiplier for recreational activity of \$1.98. A more accurate measurement of benefits to the local community would be the actual income retained by households, local governments, and nonprofit organizations of the county. By type of expenditure, these returns were estimated to be 35¢ for tourists, 48¢ for hunter-fishermen and 50¢ for summer campowners.

Comparison of Watershed Costs and Benefits. The data presented in the Appendix B Tables presents the basic information necessary to compare the development costs for each site presented in this section. Also presented here is an analysis of the efficiency with which each watershed meets the goals for which it was planned.

The data contained in Appendix B, Tables 16 and 17 were combined to obtain the data presented in Table C-1, i.e. the cost attributed to the development of each storage purpose (Appendix B, Table 16) was divided by the acre-feet of storage for each purpose (Appendix B, Table 17) to obtain a cost per acre-foot of storage for each purpose (Table C-1).

The preceding discussion has summarized and compared impacts of the early action watershed development program. The following discussions examine impacts for each of the 12 watersheds individually. Two tables are presented for each watershed. The first presents land and monetary needs necessary for two levels of reservoir development. The second table presents impacts resulting from lost economic activity, reduction in damages and increased spending. A period of ten years is used for the second table to reflect the short run period during which development activity is likely to occur. The B-C ratios discussed however, reflect the SCS PL-566 planning horizon for upstream watershed projects. The type of analysis used here was suggested by Brown.[2/]

1/ Gamble, Hays B., and Raphael, David L., A Microregional Analysis of Clinton County, Pennsylvania, The Pennsylvania Regional Analysis Group, the Pennsylvania State University, University Park, Pa.

2/ Brown, Richard N., Jr., "Preliminary Economic Impact Analysis of the Potential Development of Four Proposed Multipurpose Sites of the West Branch of the Delaware River, Delaware County, New York," Environmental Economics Branch, NRED-ERS-USDA, Washington, D.C., August, 1969.

Table C-1. Cost per acre-foot of storage for identified needs and full potential development, by site, early action watersheds, James River Basin

Watershed and Structure	Development to Meet Identified Needs				Full Development Potential				
	Flood Prevention	Water Supply	Recreation	Total	Flood Prevention	Water Supply	Recreation	Add'l Storage	Total
	Dollars per Acre-Foot[1/]								
Ogle Creek (12-3)	309	324		311	200	324	194	194	202
Site 1	213			213	129			132	131
Site 2	461			461	230			236	234
Site 3	627			627	326			334	332
Site 5	204			204	218			224	222
Site 6	328	324		325	328	324			325
Range	204-627			204-627	129-328			132-334	131-332
Dunlap Creek (12-4,5)	215	106		188	170	108		182	172
Site 1A	213			213	169			172	171
Site 2	453			453	330			336	334
Site 3A	297			297	166			169	151
Site 4	194			194	104			106	105
Site 5	108	106		106	106	108		104	107
Site 1A	212			212	160			163	162
Site 2A	162			162	176			179	178
Range	108-453			106-453	104-330			104-336	105-334
Upper Jackson River (12-6,7)	162	255	120	143	129	157	114	116	120
Site 1	205			205	130			135	134
Site 1G	74		120	103	66		114	69	90
Site 4	235	238		235	161	165		159	161
Site 4	270	271		270	157	149		157	156
Range	74-270	238-271		103-270	66-161	149-165		69-159	90-161
Cowpasture River (12-12,13,14)	166	158	178	169	91	79	170	86	96
Site 1A	213	209		212	96	111		95	96
Site 1B	115		178	151	111		170	111	131
Site 1B	130			130	50			51	65
Site 1A	284			284	115			115	115
Site 3	489			489	272			260	264
Site 7B	101	106		102	45	47		46	46
Range	101-489	106-209		102-489	45-272	47-111		46-260	46-264
Jackson River 5 (12-15)	285	248		275	195	119		207	194
Site 1B	327	326		327	154	155		155	155
Site 1C	353			353	349			354	353
Site 4A	172	169		171	86	83		84	85

See footnotes at end of table.

Table C-1. Cost per acre-foot of storage for identified needs and full potential development, by site, early action watersheds, James River Basin--Continued

Watershed and Structure	Development to Meet Identified Needs				Full Development Potential				
	Flood Prevention	Water Supply	Recreation	Total	Flood Prevention	Water Supply	Recreation	Add'l Storage	Total
	Dollars per Acre-Foot 1/								
Tye River (12-25)	225	214	388	229	198	260	353	167	182
Site 3A	217	214		212	198	260		195	197
Site 4	119		388	153	85		353	83	98
Site 5	283			283	169			171	170
Site 6	152			152	113			114	113
Range	119-283			152-283	85-198			83-195	98-197
Piney River (12-26)	248	338	210	241	212	364	210	184	203
Site 1A	250			250	175			175	175
Site 2A	344	338		343	362	364		357	362
Site 3	132		210	181	132		210		181
Site 2A	344	338		343	362	364		357	362
Site 3	132		210	181	132		210		181
Range	132-344			181-343	132-362			175-357	175-362
Hardware River (12-30)	117	109	245	142	94	66	245	90	109
Site 1	205			205	153			154	153
Site 2A	92		224	173	92		224		173
Site 3	122	123		122	70	68		71	71
Site 4	95		361	132	95		361		132
Site 5	92	93		92	63	62		64	64
Site 6	146			146	147			148	147
Range	92-205	93-123	224-361	92-205	63-153	62-68	224-361	64-154	64-173
James River 5 (12-36)	194	209		196	133	162		119	126
Site 3B	213	209		212	165	162		168	166
Site 4	155			155	83			85	84
Range	155-213			155-212	83-165			85-168	84-166
Beaver Creek (12-43)	206	163		199	163	126		168	163
Site 2	161	163		162	126	126		128	127
Site 7	283			283	228			231	230
Range	161-283			162-283	126-228			128-231	127-230

See footnotes at end of table.

Table C-1. Cost per acre-foot of storage for identified needs and full potential development, by site, early action watersheds, James River Basin--Continued

Watershed and Structure	Development to Meet Identified Needs				Full Development Potential				
	Flood Prevention	Water Supply	Recreation	Total	Flood Prevention	Water Supply	Recreation	Add'l Storage	Total
	Dollars per Acre-Foot[1/]								
Calfpasture River (12a-1)	300	296	1,163	312	192	156	1,112	193	195
Site 1	279		1,163	345	244		1,112	247	266
Site 2C	300	296		299	164	156		163	162
Site 3	882			882	296			300	299
Site 4A	411			411	287			292	290
Site 5A	357			357	346			352	350
Site 6	340			340	196			201	199
Site 7	71			71	54			53	53
Site 8	617			617	330			337	335
Range	71-882			71-882	54-346			53-352	53-350
N. Fork Rivanna River (12b-1,2,7, 12)	83	89	124	92	82	87	137	85	89
Site 3	90	87		90	89	71		89	89
Site 1C	61			61	43			43	43
Site 1	94	90		93	90	90		90	46
Site 2	133			133	123			121	122
Site 3	102			102	97			97	97
Site 6A	107			107	101			101	101
Site 11	53		124	82	67		137	67	86
Range	53-133	87-90		61-133	43-123	71-90		43-121	43-122
Total Early Action Watersheds	179	194	162	176	133	142	160	132	135
Range	53-882	87-338	210-1,623	61-882	43-362	47-364	114-1,112	43-357	43-362

1/ Base year 1967.

The cost per acre-foot of development to meet identified needs for all the early action watershed sites is $176. The comparable cost for full potential development is $135. The cost range to meet identified needs is $61 to $882 per acre-foot of storage. For full potential development the comparable range is $43 to $362. As we would expect, the cost per acre-foot, as well as the range, is lower for full potential development than for development to meet identified needs.

Costs per acre-foot for the three types of storage at the lower level of development for the early action watersheds are $179 for flood prevention, $194 for water supply, and $162 for recreation. The range for flood prevention is $53 to $882, for water supply it is $87 to $338, and for recreation the range is $120 to $1,163. For full potential development, the costs per acre-foot of storage for the three purposes are $133 for flood prevention, $142 for water supply, and $160 for recreation. The additional storage available at full development costs an average of $132 per acre-foot for all the early action sites. The cost range for the additional storage is from $43 to $357 per acre-foot.

The development cost per acre-foot is lowest for the North Fork Rivanna River watershed ($92 per acre-foot) for both levels of development. Development costs per acre-foot of total storage are highest for the Ogle Creek ($311) and Calfpasture River ($312) watersheds. Since flood prevention storage is the main purpose for all the watersheds, the same comparisons are applicable for flood prevention storage as were true for total storage. Water supply storage is cheapest in the North Fork Rivanna River, Dunlap Creek, and Hardware River watersheds and most expensive in the Ogle Creek, Piney River and Calfpasture watersheds. Recreation storage is cheapest in the Upper Jackson River and North Fork Rivanna River watersheds and most expensive in the Calfpasture River ($1,163 per acre-foot) and Tye River watersheds. At the upper level of development, the cost of the additional storage is cheapest in the Cowpasture River, Hardware River and North Fork Rivanna River watersheds and is most expensive in the Ogle Creek, Jackson River 5 and Calfpasture River watersheds.

To summarize, the least expensive watersheds to develop, using cost per acre-foot of storage as a criteria, appears to be the North Fork Rivanna River (seven sites) and Upper Jackson River (four sites) watersheds. Recreation storage cost is very expensive in the Calfpasture River watershed.

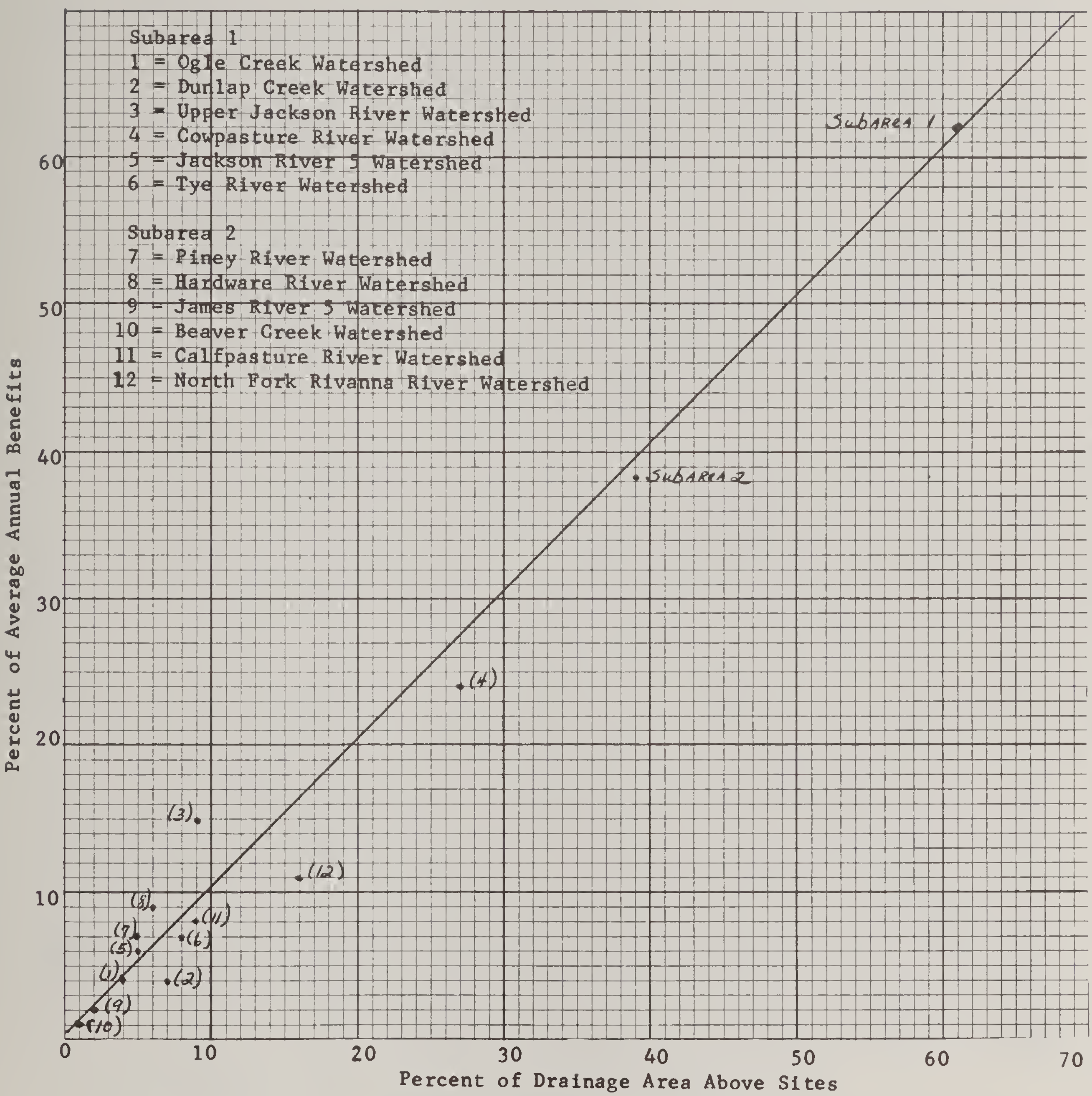
An alternative method which can be used to compare the 12 watersheds is through the use of graphs showing costs or benefits and areas protected. Graphs 7 through 10 are examples of this type of comparison using information from Appendix B, Tables 12 and 18.

Graph 7 plots the percent of the total drainage area above all the sites in each watershed against the percent of total average annual benefits attributed to all the sites in each watershed. For example, the Beaver Creek watershed contains one percent of the total drainage area above all sites in all watersheds. One percent of all average annual benefits for all sites in all watersheds is also attributed to the Beaver Creek watershed. Therefore, the dot for the Beaver Creek watershed (#10) is located at the (1,1) coordinates on the graph. Ideally, in this graph, we would like to see a higher percentage of benefits than drainage area above sites, i.e. a dot located well above a forty-five degree line (line of equal percentages) drawn through the origin of the graph. In Graph 7, we see that the dot for the Upper Jackson River watershed lies well above the line, i.e. the Upper Jackson River watershed contains only 9 percent of the total drainage area above sites but 15 percent of the total average annual benefits. This can be interpreted to mean that site development in this watershed yields a large amount of benefits in relation to the upstream area the sites control. The Hardware River watershed (#8) should also be noted for the same reason, i.e. it contains only 6 percent of the drainage above sites but has been attributed with 9 percent of the total average annual benefits. The Dunlap Creek watershed (#2) and the North Fork Rivanna River watershed (#12) should be noted for the opposite reason; they contain 16 and 7 percent of the drainage area above sites but are attributed with only 11 and 4 percent of the total average annual benefits respectively. The rest of the watersheds are very near the 45 degree line, indicating that the drainage area is very nearly equal to the benefits attributed. The watersheds in Subarea 1 can be seen to hold a slightly favorable position over the watersheds in Subarea 2.

Graph 8 plots the percent of total watershed drainage acres against the percent of average annual benefits. The interpretation is the same as in Graph 7, i.e. it is advantageous to be well above the line of equalization. Watersheds holding this position are the Piney River watershed (#7), four percent of the total drainage area but seven percent of total annual benefits, and the Upper Jackson River watershed (#3), nine percent of the total drainage area but 15 percent of the total average annual benefits. Watersheds which are well below the line, and thus at a relative disadvantage when comparing benefits with drainage acres, are the Dunlap Creek (#2), James River 5 (#9), and Calfpasture River (#11) Watersheds. Subarea 1 appears to hold an even more advantageous position in the graph than was shown in Graph 7.

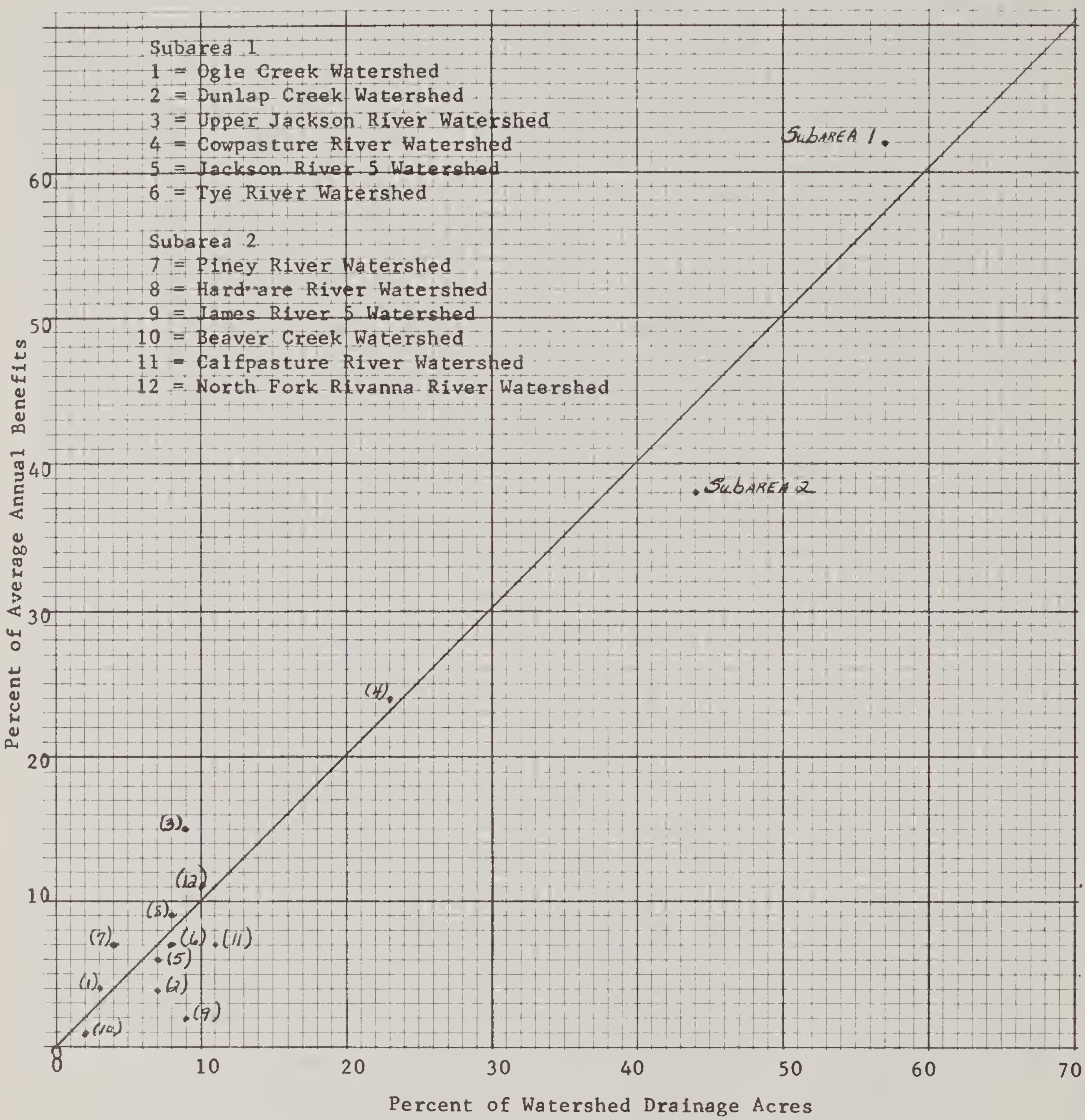
Graph 9 plots the percent of total drainage acres above sites against the percent of total average annual costs. It is more advantageous in this graph, and in Graph 10, to be located as far below the line of equalization as possible, i.e. to control the largest area at the smallest cost. The North Fork Rivanna River (#12) and Cowpasture River (#4) watersheds are shown to lie well below the line of equalization in Graph 9. The Upper Jackson River

Graph 7.
Percentage comparison of drainage area above sites with average annual benefits,[1/] early action watersheds, James River Basin.



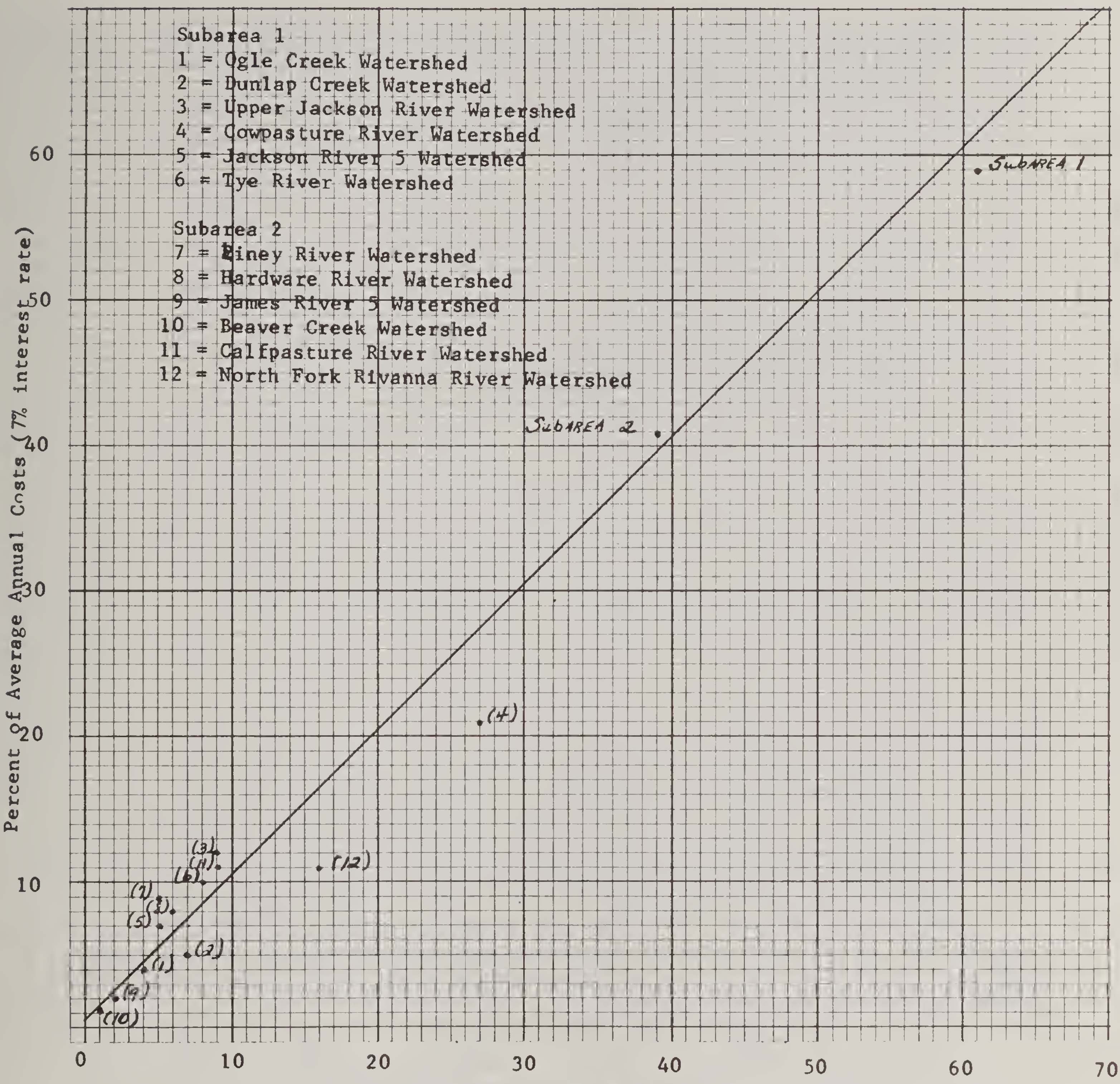
1/ Base year 1967.

Graph 8.
Percentage comparison of watershed drainage acres with average annual benefits,1/ early action watersheds, James River Basin



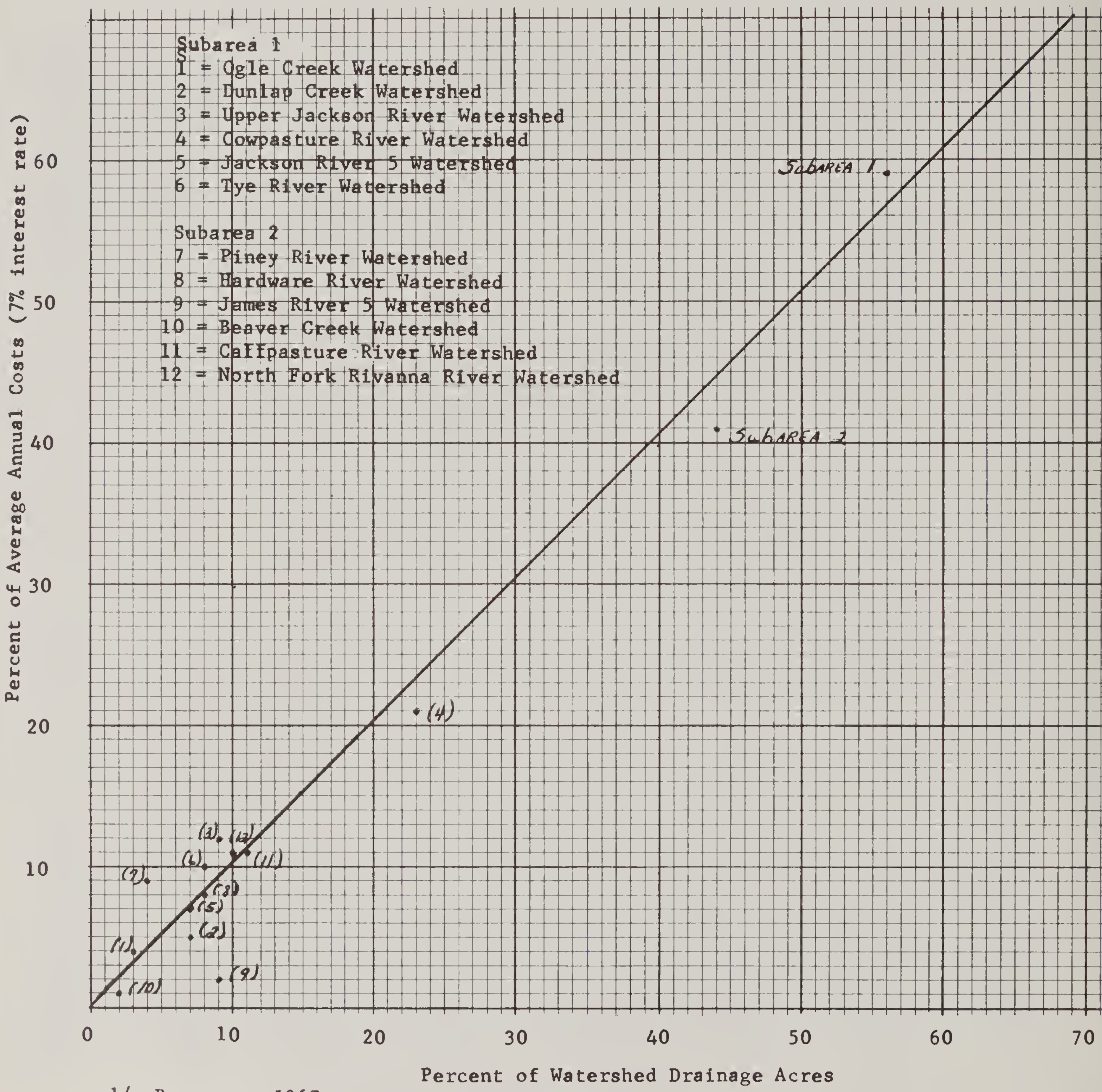
1/ Base year 1967.

Graph 9.
Percentage comparison of drainage area above sites with average annual costs 1/, early action watersheds, James River Basin



1/ Base year 1967.

Graph 10 -- Percentage comparison of watershed drainage acres with average annual costs,1/ early action watersheds, James River Basin



1/ Base year 1967.

(#3) and Piney River (#7) watersheds lie well above the line. The dot for Subarea 1 lies slightly below the line while the dot for Subarea 2 lies slightly above the line.

Graph 10 compares the percent of total watershed drainage acres with the percent of total average annual costs. The James River 5 watershed (#9) holds a relatively favorable position and the Upper Jackson River (#3) and Piney River (#7) watersheds hold relatively poor positions. Subarea 2, for the first time, holds a more favorable position than Subarea 1.

The data in this section presents sometimes contradictory information. Therefore, before the planner can use the information present, it may be necessary for him to first choose the criteria upon which he wants to base his decision.

The preceding discussion has summarized the aggregate impacts of the early action watershed development program. The following discussions examine impacts for each of the 12 watersheds individually. The second table of each section describes economic impacts generated for the first 10 years after development begins in each watershed. A 10-year frame was used for analysis because it was estimated by SCS that it would take 10 years from the time that land acquisition activities begin (first money is paid to the public) until the project is completely developed (all monetary payments cease except for annual operation and maintenance expenditures). In the second table for each watershed, all impacts of economic activity described are annual expect those listed for No. 2, which are the 10-year impacts discussed above.

<u>Ogle Creek (12-3)</u>

The impacts resulting from development of the Ogle Creek watershed are summarized in Tables C-2 and C-3. Table C-2 presents the land and monetary needs necessary for both levels of reservoir development. Table C-3 presents the impacts resulting from lost economic activity, reduction in damages, and increased spending. The benefits contained in parts 2, 3, and 4 of Table C-3 must be compared with the costs presented in Table C-2 and parts 1 and 5 of Table C-3 to decide whether the benefits outweigh the costs, making it advantageous to develop the watershed.

Development of the watershed to its fullest potential will require that easements be obtained for at least 392 acres of land, more if access routes and borrow areas are necessary. Easements for only 203 acres of land would be necessary at the lower level of development (to meet identified needs). Examination of Table C-2 will indicate the amounts of land and money necessary to develop each site. In this way the local planner can determine the tradeoffs between the costs and benefits of both levels of development. Perhaps it is most advantageous to fully develop only one or two sites, depending on the needs of the community as determined by

the local planner. For instance, site 1 requires much more land than any of the other sites so that if the size of pool is important, site 1 has an advantage or disadvantage, depending on community goals.

Table C-3 indicates that if the Ogle Creek watershed is developed to its fullest potential, $9,400 of agricultural and $2,280 of forest product sales (at 1969 yields and prices) will be lost annually because of productive land being inundated. This loss of sales may be partially or wholly offset by increased productivity on downstream acres protected from flooding. Dollars lost because of other economic activity destroyed is shown to be zero but can be changed if additional information becomes available. Two multipliers have been applied to the figures shown in Table C-3 to obtain a range of values for the secondary effects resulting from losses of agriculture and forest product sales. The magnitude of multiplier effects vary from region to region, depending on the portion of the money spent which remains in the region and is respent. Local planners can specify the multiplier they wish to use based upon their knowledge of monetary leakages from the community. The multiplier of 2.0 was used for summing the impacts shown in Table C-3.

Similarly shown in Table C-3 are the purchase, construction, and multiplier effects of reservoir development. These are one-time only expenditures and it must be recognized that the multipliers may vary for each category of expenditure as well as for different levels of expenditures. These are some of the reasons why it is very difficult to specify a single multiplier and to compute all impacts using it.

Expenditures and impacts of annual operations shown in Table C-3 are divided into operation and maintenance, recreation, and water supply. Recreation consists of incidental recreation on flood control structures unless recreation storage is specified or unless adjacent recreational areas are recommended for development. Water supply impacts are on a development cost basis and must be revalued by local planners based on user charges. Again the 2.0 multiplier was used when totaling first round expenditures and impacts.

Table C-3 also lists other annual benefits and their multiplier effects as determined by SCS in their Watershed Investigation Reports. These benefits and their impacts vary widely depending upon local conditions at the time of development and should be reevaluated before development of any site begins.

Other impacts which cannot be assigned on economic value must also be considered. These include disruption of religious and family relationships resulting from relocation of the church and residences. The completion of Interstate 64 will undoubtedly increase the rate of development in the flood plains of this watershed, thereby resulting in increased demand for municipal services (water supply) and recreational opportunities. This will also greatly increase the need for flood protection.

Table C-2. Summary of levels of development for Ogle Creek watershed (12-3), James River Basin

Specifications or Costs	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
I. Amount of Land Required (acres)			
Site 1	85	183	
Site 2	32	70	
Site 3	17	39	
Site 5	23	54	
Site 6	46	46	
Total	203	392	(none)
II. Installation Cost 2/ (dollars)			
a. Land, Easements, Right of Way 1/			
Site 1	92,200	150,000	
Site 2	52,500	129,000	
Site 3	2,200	4,000	
Site 5	11,100	14,000	
Site 6	15,800	15,800	
Subtotal	173,800	312,800	(none)
b. Construction			
Site 1	377,700	895,500	
Site 2	306,300	540,200	
Site 3	338,800	653,100	
Site 5	162,700	689,400	
Site 6	368,000	368,000	
Subtotal	1,552,800	3,146,200	(none)
c. Installation Services			
Site 1	60,200	142,300	
Site 2	49,000	86,100	
Site 3	53,900	103,800	
Site 5	31,300	109,700	
Site 6	66,700	66,700	
Subtotal	261,100	508,600	(none)
d. Total Installation Costs			
Site 1	529,400	1,198,800	
Site 2	407,800	755,300	
Site 3	394,900	760,900	
Site 5	205,100	813,100	
Site 6	450,500	450,500	
Total	1,987,700	3,967,600	(none)

Source: Watershed Investigation Reports.

1/ See Footnote 1/, Table C-3.

2/ Base year 1967.

Table C-3. Summary of economic impacts generated for the first 10 years after consturction begins for Ogle Creek watershed (12-3), James River Basin

Type of Economic Impact	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
	Dollars[5/]		
A. Economic Activity			
1. Destoryed (Annually Indefinitely)[2/]	12,160	23,360	
A. Generated by agriculture[1/]	4,900	9,400	(none)
b. Generated by forest land[1/]	1,180	2,280	
c. Generated by other activity displaced	0	0	
d. Multiplier effects (0.5)	3,040	5,840	
(1.5)	9,120	17,520	
2. Generated by Use Conservation Activities: (once)	3,975,400	7,935,200	
a. Land[4/], easements & right of way	173,800	312,800	
b. Construction of structures & service	1,813,900	3,654,800	
c. Multiplier effects (0.5)	993,800	1,983,800	
(1.5)	2,981,500	5,951,400	
3. Generated by Annual Operations	39,400	39,400	
a. Operation & maintenance	1,500	1,500	
b. Recreation	1,190	1,190	
c. Water supply	17,000	17,000	
d. Multiplier effects (0.5)	9,800	9,800	
(1.5)	29,500	29,500	
4. Other Annual Benefits[2/,3/]	252,100	252,100	
a. Damage reduction	82,830	82,380	
b. Changed use & redevelopment	32,100	32,100	
c. Local secondary	11,110	11,110	
d. Multiplier effects (1.0)	126,000	126,000	
5. Other Impacts			
a. Church relocation			

Source: Topographic maps and Watershed Investigation Reports.

1/ Both levels of development assume the same percentage of each type of land in the emergency spillway pool area. The actual percentage at the lower level of development was determined from site maps.

2/ This sum reflects a multiplier effect of 2.0.

3/ Benefits resulting from the higher level of development may be greater than reported here.

4/ The land cost includes the sale value of the standing timber.

5/ Base year 1967.

Table C-1 presents cost per acre-foot of storage data for each of the reservoir sites in the Ogle Creek watershed. At the lower level of development the average cost per acre-foot of storage is $311, with a range from $204 to $607 per acre-foot. At the upper level of development the average cost is $202 per acre-foot, with a range from $131 to $332. Site 3 is the most expensive site to develop ($627 per acre-foot) and site 5 is the least expensive site ($204 per acre-foot). The water supply storage planned for site 6 costs $324 per acre-foot. Full development of site 1 reduces the average cost substantially, to $131 per acre-foot of storage, thus indicating that the cost benefits of full development are greatest for site 1. Planners should use the data in Table C-1 when deciding what trade-offs can be made between alternative purposes and costs.

Dunlap Creek (12-4,5)

The impacts resulting from development of the Dunlap Creek watershed are summarized in Tables C-4 and C-5. Table C-4 presents the land and monetary needs necessary for both levels of reservoir development. Table C-5 presents the impacts resulting from lost economic activity, reduction in damages and increased spending. The benefits contained in parts 2, 3, and 4 of Table C-5 must be compared with the costs presented in Table C-4 and parts 1 and 4 of Table C-5 to decide whether the benefits outweigh the costs, making it advantageous to develop the watershed.

Development of the watershed to its fullest potential will require that easements be obtained for 634 acres of land, more if access routes and borrow areas are necessary. Easements for only 333 acres of land would be necessary at the lower level of development (to meet identified needs). Examination of Table C-4 will indicate the amounts of land and money necessary to develop each site. In this way the local planner can determine the trade-offs between the costs and benefits of both levels of development. Perhaps it is most advantageous to fully develop only one or two sites, depending on the needs of the community as determined by the planner. Site 5 requires the greatest amount of land at the lower level of development and sites 3A, 5 and 2A require the greatest land areas, if developed to their fullest potential. Total installation costs are highest for sites 3A, 5 and 2A at the lower level of development and for sites 1A and 2A at the upper level of development.

Table C-5 indicates that if the Dunlap Creek watershed is developed to its fullest potential, $5,240 of agricultural and $5,390 of forest product sales (1969 yields and prices) will be lost annually because of inundation of productive land. This loss of sales may be wholly or partially offset by increased productivity on downstream acres protected from flooding. Dollars lost because of other economic activity destroyed is shown to be zero but can be

changed if additional information becomes available. Two multipliers have been applied to the figures.[1]

Table C-5 also shows the purchase, construction; and multiplier effects of reservoir development. The expenditures and impacts of annual operations are divided into operations and maintenance, recreation and water supply. Recreation consists of incidental recreation on flood control structures, unless recreation storage is specified or unless adjacent recreational areas are recommended for development. Water supply impacts are on a development cost basis and must be revalued by local planners based on user charges. Again the 2.0 multiplier was used when totaling first round expenditures and impacts.

Table C-5 also lists other annual benefits and their multiple-effects as determined by SCS in their Watershed Investigation Reports. These benefits and their impacts vary widely depending upon local conditions at the time of development and should be reevaluated before development of any site begins.

Other impacts which cannot be assigned an economic value must also be considered. These include description of family and religious relationships resulting from residential relocation. Impacts of this type are of minor importance in this watershed. The completion of Interstate 64 will undoubtedly increase the rate of development in the flood plains of this watershed, thereby resulting in increased demand for municipal services, recreational facilities and flood protection.

Table C-1 presents cost per acre-foot of storage data for each of the reservoir sites in the Dunlap Creek watershed. At the lower level of development the average cost per acre-foot of storage is $188, with a range from $106 to $453 per acre-foot. At the upper level of development the average cost is $172 per acre-foot, with a range from $105 to $334. Site 2 is the most expensive site to develop ($453 per acre-foot) and site 5 is the least expensive site ($108 per acre-foot). The water supply storage planned for site 5 costs $106 per acre-foot. Full development of site 3A lowers the cost per acre-foot of storage from $297 to $151, thus indicating that the cost benefits of full development are greatest for site 3A. Full development of sites 5 and 2A increases the average cost per acre-foot of storage. Planners should use the data in Table IX-3 when deciding what trade-offs can be made between alternative purposes and costs.

1/ See the introduction to this impact section for a discussion of the use of multipliers.

Table C-4. Summary of levels of development for Dunlap Creek Watershed (12-4,5), James River Basin

	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
I. Amount of Land Required (acres)			
Site 1A	27	63	
Site 2	24	55	
Site 3A	50	125	
Site 4	35	65	
Site 5	117	122	
Site 1A	32	90	
Site 2A	48	114	
Total	333	634	(none)
II. Installation Costs (dollars) 2/			
a. Land, Easements & Right of Way 1/			
Site 1A	3,300	10,800	
Site 2	3,000	9,300	
Site 3A	9,800	33,800	
Site 4	5,900	11,000	
Site 5	21,300	22,200	
Site 1A	5,700	17,000	
Site 2A	7,800	21,000	
Subtotal	56,800	125,100	(none)
b. Construction			
Site 1A	175,300	540,200	
Site 2	272,100	766,900	
Site 3A	389,300	802,600	
Site 4	58,100	130,400	
Site 5	378,800	409,300	
Site 1A	313,500	881,700	
Site 2A	383,600	1,568,300	
Subtotal	1,970,700	5,099,400	(none)
c. Installation Services			
Site 1A	36,400	81,400	
Site 2	56,300	115,400	
Site 3A	62,000	120,800	
Site 4	17,600	19,900	
Site 5	68,600	62,100	
Site 1A	50,100	132,700	
Site 2A	61,000	235,700	
Subtotal	352,000	768,000	(none)
d. Total Installation Costs			
Site 1A	215,000	632,400	
Site 2	331,400	891,600	
Site 3A	461,100	957,200	
Site 4	81,600	161,300	
Site 5	468,700	493,600	
Site 1A	369,300	1,031,400	
Site 2A	452,400	1,825,000	
Total	2,379,500	5,992,500	(none)

Source: Watershed Investigation Reports.

1/ See Footnote 1/. Table C-5.

2/ Base year 1967.

Table C-5. Summary of economic impacts generated for the first 10 years after construction begins for Dunlap Creek watershed (12-4,5), James River Basin

Type of Economic Impact	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
	Dollars[5]		
A. Economic Activity			
1. Destroyed (Annually indefinitely)[2]	11,180	21,260	
a. Generated by agriculture[1]	2,760	5,240	
b. Generated by forest land[1]	2,830	5,390	
c. Generated by other activity displaced	0	0	
d. Multiplier effects (0.5)	2,795	5,315	
(1.5)	8,385	15,945	
2. Generated by Use Conservation Activities (once)	2,559,000	11,765,000	
a. Land[4], easements & right of way	56,800	125,000	
b. Construction of structures & services	1,222,700	5,757,400	
c. Multiplier effects (0.5)	639,800	2,941,200	
(1.5)	1,919,200	8,823,800	
3. Generated by Annual Operations	45,000	45,000	
a. Operation & maintenance	3,500	3,500	
b. Recreation	2,000	2,000	
c. Water supply	17,000	17,000	
d. Multiplier effects (0.5)	11,200	11,200	
(1.5)	33,800	33,800	
4. Other Annual Benefits[2],[3]	246,800	246,800	
a. Damage reduction	69,420	69,420	
b. Changed use & redevelopment	43,610	43,610	
c. Local secondary	10,380	10,380	
d. Multiplier effects (1.0)	123,400	123,400	
5. Other Impacts			
a. None			

Source: Topographic maps and Watershed Investigation Reports.

1/ Both levels of development assume the same percentage of each type of land in the emergency spillway pool area. The actual percentage at the lower level of development was determined from site maps.

2/ This sum reflects a multiplier effect of 2.0.

3/ Benefits resulting from the higher level of development may be greater than reported here.

4/ The land cost includes the sale value of the standing timber.

5/ Base year 1967.

Upper Jackson River (12-6,7)

The impacts resulting from development of the Upper Jackson River watershed summarized in Tables C-6 and C-7. Table C-6 presents the land and monetary needs necessary for both levels of reservoir development. Table C-7 presents the impacts resulting from lost economic activity, reduction in damages and increased spending. The benefits contained in parts 2, 3, and 4 of Table C-7 must be compared with the costs presented in Table C-6 and parts 1 and 5 of Table C-7 to decide whether the benefits outweigh the costs, making it advantageous to develop the watershed.

Development of the watershed to its fullest potential will require that easements be obtained for 1,334 acres of land, more if access routes and borrow areas are necessary. Easements for only 862 acres of land would be necessary at the lower level of development (to meet identified needs). Examination of Table C-6 will indicate the amounts of land and money necessary to develop each site. In this way the local planner can determine the trade-offs between the costs and benefits of both levels of development. Perhaps it is most advantageous to fully develop only one or two sites, depending on the needs of the community as determined by the planner. Site 1G requires the greatest amount of land at both the lower level of development and if developed to its fullest potential. Total installation costs are also highest for site 1G at both the lower level of development and at the upper level of development.

Table C-7 indicates that if the Upper Jackson River watershed is developed to its fullest potential, $53,200 of agricultural and $2,520 of forest product sales (1969 yields and prices) will be lost annually because of inundation of productive land. This loss of sales may be wholly or partially offset by increased productivity on downstream acres protected from flooding. Dollars lost because of other economic activity destroyed is shown to be zero but can be changed if additional information becomes available. Two multipliers have been applied to the figures.1/

Table C-7 also shows the purchase, construction; and multiplier effects of reservoir development. The expenditures and impacts of annual operations are divided into operation and maintenance, recreation and water supply. Recreation consists of incidental recreation on flood control structures unless recreation storage is specified or unless adjacent recreational areas are recommended for development. Water supply impacts are on a development cost basis and must be revalued by local planners based on user charges. Again the 2.0 multiplier was used when totaling first round expenditures and impacts.

1/ See the introduction to this impact section for a discussion of the use of multipliers.

Table C-6. Summary of levels of development for Upper Jackson River watershed (12-6,7), James River Basin

Specifications or Costs	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
I. Amount of Land Required (acres)			
Site 1	70	167	
Site 1G	624	645	96
Site 4	108	217	
Site 4	60	105	
Total	862	1,334	96
II. Installation Costs (dollars) 2/			
a. Land, Easements & Right of Way 1/			
Site 1	30,000	72,000	
Site 1G	401,000	457,900	62,600
Site 4	132,000	264,000	
Site 4	41,000	57,400	
Channel Improvement	1,000	1,000	
Subtotal	605,000	825,300	62,600
b. Construction			
Site 1	252,800	555,200	
Site 1G	1,225,200	1,440,500	552,000
Site 4	368,600	667,600	
Site 4	323,600	449,400	
Channel Improvement	359,200	359,200	
Subtotal	2,529,400	3,471,900	552,000
c. Installation Services			
Site 1	52,100	83,000	
Site 1G	194,300	248,500	138,800
Site 4	66,600	100,700	
Site 4	58,600	68,200	
Channel Improvement	123,500	123,500	
Subtotal	495,100	624,800	138,800
d. Total Installations Costs			
Site 1	334,900	711,100	
Site 1G	1,820,500	2,146,900	753,400
Site 4	567,500	1,032,300	
Site 4	423,200	575,000	
Channel Improvement	483,700	483,700	
Total	3,629,500	4,949,000	753,400

Source: Watershed Investigation Reports.

1/ See footnote 1/, Table C-7.

2/ Base year 1967.

Table C-7. Summary of economic impacts generated for the first 10 years after construction begins, Upper Jackson River watershed (12-6,7), James River Basin

Type of Economic Impact	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
A. Economic Activity	Dollars[7/]		
1. Destroyed (Annually Indenfinitely)[2/]	72,060	111,440	1,600
a. Generated by agriculture[1/]	34,400	53,200	800[4/]
b. Generated by forest land[1/]	1,630	2,520	0
c. Generated by other activity displaced	0	0	0
d. Multiplier effects (0.5)	18,015	27,860	400
(1.5)	54,045	83,580	1,200
2. Generated by Use Conservation Activities (once)[2/]	7,259,000	9,898,000	1,506,800
a. Land,[6/] easements & rights of way	605,000	852,300	62,600
b. Construction of structures & service	3,024,500	4,096,700	690,800
c. Multiplier effects (0.5)	1,814,800	2,474,500	376,700
(1.5)	5,444,200	7,423,500	1,130,100
3. Generated by Annual Operations	142,500	142,500	497,700
a. Operation & maintenance	57,600	57,600	13,590
b. Recreation	1,640	1,640	235,250
c. Water supply	12,000	12,000	0
d. Multiplier effects (0.5)	35,600	35,600	124,400
(1.5)	106,900	106,900	373,300
4. Other Annual Benefits[2/],[3/]	450,900	450,900	
a. Damage reduction	113,690	113,690	
b. Changed use & redevelopment	73,680	73,680	
c. Local secondary	38,100	38,100	5/
d. Multiplier effects (1.0)	225,470	225,470	
5. Other Impacts			
a. None			

Source: Topographic maps and Watershed Investigation Reports.

1/ Both levels of development assume the same percentage of each type of land in the emergency spillway pool area. The actual percentage at the lower level of development was determined from site maps.

2/ This sum reflects a multiplier effect of 2.0.

3/ Benefits resulting from the higher level of development may be greater than reported here.

4/ This figure is 10 percent of the land area required multiplied by the market value of all agricultural products sold per acre in the watershed.

5/ Changed use the redevelopment resulting from the recreational area were not estimated.

6/ The land cost includes the sale value of the standing timber.

7/ Base year 1967.

Table C-7 also lists other annual benefits and their multiplier effects as determined by SCS in their Watershed Investigation Reports. These benefits and their impacts vary widely depending upon local conditions at the time of development and should be reevaluated before development of any site begins.

Other impacts which cannot be assigned an economic value must also be considered. These include disruption of family and religious relationships resulting from residential relocations. Impacts of this type are of minor importance in this watershed.

The Upper Jackson Creek watershed is immediately upstream on the Jackson River from the upper end of the nearby completed Gaithright Reservoir and recreation area. The level of development surrounding Gaithright and its impact on meeting the needs and problems of the area should be considered when making the final decision concerning final development levels.

Table C-1 presents cost per acre-foot of storage data for each of the reservoir sites in the Upper Jackson River watershed. At the lower level of development the average cost per acre-foot of storage is \$143, with a range from \$103 to \$370 per acre-foot. At the upper level of development the average cost is \$120 per acre-foot, with a range for \$90 to \$161. Site 4(12-7) is the most expensive site to develop (\$270 per acre-foot) and site 1G is the least expensive site (\$74 per acre-foot). The water supply storage planned for sites 4 (12-6) and 4 (12-7) costs \$238 and \$271 per acre-foot respectively. The recreation storage planned for site 1G costs \$120 per acre-foot of storage. Full development of Site 4 (12-7) reduces the average cost per acre-foot of storage from \$270 to \$156, indicating that the cost benefits of full development are greatest for site 4 (12-7). The cost of water supply storage at full development of site 4 (12-7) is reduced to \$149 per acre-foot. Planners should use the data in Table C-1 when deciding what trade-offs can be made between alternative purposes and costs.

Cowpasture River (12-12,13,14)

The impacts resulting from development of the Cowpasture River Watershed are summarized in Tables C-8 and C-9. Table C-8 presents the land and monetary needs necessary for both levels of reservoir development. Table C-9 presents the impacts resulting from lost economic activity, reduction in damages and increased spending. The benefits contained in parts 2, 3, and 4 of Table C-9 must be compared with the costs presented in Table C-8 and parts 1 and 5 of Table C-9 to decide whether the benefits outweigh the costs, making it advantageous to develop the watershed.

Development of the watershed to its fullest potential will require that easements be obtained for 3,220 acres of land, more if access routes and borrow areas are necessary. Easements for only 1,467 acres of land would be necessary at the lower level of development (to meet identified needs). Examination of Table IX-10 will indicate the amounts of land and money necessary to develop each site. In this way the local planner can determine the trade-offs between the costs and benefits of both levels of development. Perhaps it is most advantageous to fully develop only one or two sites, depending on the needs of the community as determined by the planner. Site 1B (12-12) requires the greatest amount of land at both the lower level of development if developed to its fullest potential. Total installation costs are also highest for site 1B (12-12) at both the lower level of development and the upper level of development.

Table IX-11 indicates that if the Cowpasture River watershed is developed to its fullest potential, $166,800 of agricultural and $7,220 of forest product sales (1969 yields and prices) will be lost annually because of inundation of productive land. This loss of sales may be wholly or partially offset by increased productivity on downstream acres protected from flooding. Dollars lost because of other economic activity destroyed is shown to be zero but can be changed if additional information becomes available. Two multipliers have been applied to the figures.1/

Table C-9 also shows the purchase, construction; and multiplier effects of reservoir development. The expenditures and impacts of annual operations are divided into operation and maintenance, recreation and water supply. Recreation consists of incidental recreation on flood control structures unless recreation storage is specified or unless adjacent recreational areas are recommended for development. Water supply impacts are on a development cost basis and must be revalued by local planners based on user charges. Again the 2.0 multiplier was used when totaling first round expenditures and impacts.

Table C-9 also lists other annual benefits and their multiplier effects as determined by SCS in their Watershed Investigation Reports. These benefits and their impacts vary widely depending upon local conditions at the time of development and should be reevaluated before development of any site begins.

The BOR and the Virginia Division of Water Resources has estimated that the unsatisfied demand for recreational water surface in this area is 2,000 acres. An estimated 600 acres is needed for trout and warm water fishing alone. Visual landscape studies in the area indicate

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1/ See the introduction to this impact section for a discussion of the use of multipliers.

that the present water surface area should be at least tripled. Approximately six miles of the 133 miles of trout and trout feeder streams in the watershed would be affected by construction areas an impoundment areas. Cold water release devices could preserve existing habitats in downstream areas. Water at normal pool level would provide 772 acres in six impoundments to replace the loss of trout fishing stream areas and do furnish other recreational opportunities.

Other impacts which cannot be assigned an economic value must also be considered. These include disruption of family and religious relationships resulting from residential relocations. These relationships do not appear to be an important consideration in this watershed.

Table C-1 presents cost per acre-foot of storage data for each of the reservoir sites in the Cowpasture River watershed. At the lower level of development the average cost per acre-foot of storage is $169, with a range from $102 to $489 per acre-foot. At the upper level of development the average cost is $96 per acre-foot, with a range from $46 to $264. Site 3 is the most expensive site ($89 per acre-foot). The water supply storage planned for sites 1A (12-12) and 3 (12-14) costs $209 and $106 per acre-foot respectively. The recreation storage planned for site 1B (12-12) costs $178 per acre-foot. Full development of site 1A (12-14) reduces the average cost per acre-foot of storage from $284 to $115, indicating that the cost benefits of full development are greatest for this site. Full development of site 1A (12-12) reduces the cost of water supply storage from $209 per acre-foot to $111 per acre-foot. Similar costs for Site 7B (12-14) are $106 and $47 per acre-foot. Planners should use the data in Table IX-3 when deciding what trade-offs can be made between alternative purposes and costs.

Jackson River 5 (12-15)

The impacts resulting from development of the Jackson River 5 Watershed are summarized in Tables C-10 and C-11. Table C-10 presents the land and monetary needs necessary for both levels of reservoir development. Table C-11 presents the impacts resulting from lost economic activity, reduction in damages and increased spending. The benefits contained in Parts 2, 3, and 4 of Table C-11 must be compared with the costs presented in Table C-10 and Parts 1 and 5 of Table C-11 to decide whether the benefits outweigh the costs making it advantageous to develop the watershed.

Development of the watershed to its fullest potential will require that easements be obtained for 538 acres of land, more if access routes and borrow areas are necessary. Easements for only

Table C-10. Summary of levels of development for Jackson River 5 watershed (12-15), James River Basin

Specifications or Costs	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
I. Amount of Land Required (acres)			
Site 1B	120	200	
Site 1C	115	214	
Site 4A	79	124	
Total	314	538	(none)
II. Installation Costs 2/ (dollars)			
a. Land, Easements & Right of Way 1/			
Site 1B	82,500	132,000	
Site 1C	13,300	45,300	
Site 4A	25,500	41,800	
Subtotal	121,300	219,100	(none)
b. Construction			
Site 1B	1,172,100	1,208,800	
Site 1C	777,300	2,654,900	
Site 4A	586,000	635,100	
Subtotal	2,535,400	4,498,800	(none)
c. Installation Service			
Site 1B	185,400	206,300	
Site 1C	122,900	419,800	
Site 4C	92,900	98,800	
Subtotal	399,900	724,900	(none)
d. Total Installation Costs			
Site 1B	1,440,000	1,547,100	
Site 1C	913,500	3,120,000	
Site 4A	704,400	775,700	
Total	3,057,900	5,442,800	(none)

Source: Watershed Investigation Reports.

1/ See Footnote 1/, Table C-11.

2/ Base year 1967.

Table C-11. Summary of economic impacts generated for the first 10 years after construction begins for Jackson River 5 watershed (12-15), James River Basin

Type of Economic Impact	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
	Dollars[5]		
A. Economic Activity			
1. Destroyed (Annually Idenfinitely)[2]	11,240	19,260	
a. Generated by agriculture[1]	3,030	5,190	(None)
b. Generated by forest land[1]	2,590	4,440	
c. Generated by other activity displaced	0	0	
d. Multiplier effects (0.5)	2,810	4,815	
(1.5)	8,430	14,445	
2. Generated by Use Conservation Activities (once)	6,113,200	10,885,600	
a. Land,[4] easements & rights of way	121,300	219,100	
b. Construction of structures & services	2,935,300	5,223,700	
c. Multiplier effects (0.5)	1,528,300	2,721,400	
(1.5)	4,584,900	8,164,200	
3. Generated by Annual Operations	83,900	83,900	
a. Operation & maintenance	4,000	4,000	
b. Recreation	2,210	2,210	
c. Water supply	35,750	35,750	
d. Multiplier effects (0.5)	21,000	21,000	
(1.5)	62,900	62,900	
4. Other Annual Benefits[2], [3]	319,800	319,800	
a. Damage reduction	93,560	93,560	
b. Changed use & redevelopment	51,670	51,670	
c. Local secondary	14,690	14,690	
d. Multiplier effects (1.0)	159,900	159,900	
5. Other Impacts			
a. Douthat State Park			
b. Many residences			

Source: Topographic maps and Watershed Investigation Reports.

1/ Both levels of development assume the same percentage of each type of land in the emergency spillway pool area. The actual percentage at the lower level of development was determined from site maps.

2/ This sum reflects a multiplier effect of 2.0.

3/ Benefits resulting from the higher level of development may be greater than reported here.

4/ The land cost includes the sale value of the standing timber.

5/ Base year 1967.

314 acres of land would be necessary at the lower level of development (to meet identified needs). Examination of Table 10 will indicate the amounts of land and money necessary to develop each site. In this way the local planner can determine the trade-offs between the costs and benefits of loth levels of development. Perhaps it is most advantageous to fully develop only one or two sites, depending on the needs of the community as determined by the planner. Sites 1B and 1C require the greatest amount of land at both the lower level of development and if developed to their fullest potential. Total installation costs are highest for site 1B at the lower level of development and for site 1C at the upper level of development.

Table 11 indicates that if the Jackson River 5 watershed is developed to its fullest potential, $5,190 of agricultural and $4,440 of forest product sales (1969 yields and prices) will be lost annually because of inundation of productive land. This loss of sales may be wholly or partially offset by increased productivity on downstream acres protected from flooding. Dollars lost because of other economic activity destroyed is shown to be zero but can be changed if additional information becomes available. Two multipliers have been applied to the figures.[1/]

Table 11 also shows the purchase, construction; and multiplier effects of reservoir development. The expenditures and impacts of annual operations are divided into operation and maintenance, recreation and water supply. Recreation consists of incidental recreation on flood control structures unless recreation storage is specified or unless adjacent recreational areas are recommended for development. Water supply impacts are on a development cost basis and must be revalued by local planners based on user charges. Again the 2.0 multiplier was used when totaling first round expenditures and impacts.

Table 11 also lists other annual benefits and their multiplier effects as determined by SCS in their Watershed Investigation Reports. These benefits and their impacts vary widely depending upon local conditions at the time of development and should be reevaluated before development of any site begins.

Other impacts which cannot be assigned an economic value must also be considered. These include disruption of family and religious relationships resulting from residential relocation. Impacts of this type are of minor importance in this watershed. The completion of Interstate 64 will undoubtedly increase the rate of development in the flood plains of this watershed, thereby resulting in increased demand for municipal services, recreational facilities and flood protection.

Table 1 presents cost per acre-foot of storage data for each of the reservoir sites in the Jackson River 5 watershed. At the lower level

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1/ See the introduction to this impact section for a discussion of the use of multipliers.

of development the average cost per acre-foot of storage is $275, with a range from $171 to $353 per acre-foot. At the upper level of development the average cost is $194 per acre-foot, with a range from $85 to $353. Site 1C is the most expensive site to develop ($353 per acre-foot) and site 4A is the least expensive site ($171 per acre-foot). The water supply storage planned for sites 1B and 4A cost $326 and $169 per acre-foot respectively. Full development of site 1B reduces the water supply storage cost from $326 to $155 per acre-foot. Similar figures for site 4A are $169 and $83. Full development of site 1B provides the greatest reduction in average costs of storage. Planners should use the data in Table 1 when deciding what trade-offs can be made between alternative purposes and costs.

Average annual benefits have been computed to be $237,000 and average annual costs using a seven percent interest rate are $310,800. The B-C ratio is therefore 0.8:1. Use of a 5-3/8 percent interest rate produces a B-C ratio of 1.1:1.

Tye River (12-25)

The impacts resulting from development of the Tye River watershed are summarized in Tables 12 and 13. Table 12 presents the land and monetary needs necessary for both levels of reservoir development. Table 13 presents the impacts resulting from lost economic activity, reduction in damages and increased spending. The benefits contained in parts 2, 3 and 4 of Table 13 must be compared with the costs presented in Table 12 and parts 1 and 5 of Table 13 to decide whether the benefits outweigh the costs, making it advantageous to develop the watershed.

Development of the watershed to its fullest potential will require that easements be obtained for 999 acres of land, more if access routes and borrow areas are necessary. Easements for only 496 acres of land would be necessary at the lower level of development (to meet identified needs). Examination of Table 12 will indicate the amounts of land and money necessary to develop each site. In this way the local planner can determine the trade-offs between the costs and benefits of both levels of development. Perhaps it is most advantageous to fully develop only one or two sites, depending on the needs of the community as determined by the planner. Sites 3A and 4 require the greatest amount of land at the lower level of development and site 3A requires the greatest land area if developed to its fullest potential. Total installation costs are highest for site 3A at both the lower level of development and at the upper level of development.

Table 13 indicates that if the Tye River watershed is developed to its fullest potential, $46,769 of agricultural and $4,950 of forest product sales (1969 yields and prices) will be lost annually because of inundation of productive land. This loss of sales may be wholly or

Table C-12. Summary of levels of development for Tye River watershed (12-25), James River Basin

Specifications or Costs	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
I. Amount of Land Required (acres)			
Site 3A	225	473	
Site 4	171	303	50
Site 5	30	60	
Site 6	70	163	
Total	496	999	50
II. Installation Cost 2/ (dollars)			
a. Land, Easements & Right of Way 1/			
Site 3A	475,000	540,000	
Site 4	101,000	127,000	15,000
Site 5	26,300	29,300	
Site 6	15,000	39,000	
Channel Improvement	53,700	53,700	
Subtotal	671,000	789,000	15,000
b. Construction			
Site 3A	1,863,800	4,920,000	
Site 4	327,100	590,000	96,800
Site 5	114,300	174,800	
Site 6	112,000	196,600	
Channel Improvement	344,400	344,400	
Subtotal	2,761,600	6,225,800	96,800
c. Installation Services			
Site 3A	335,000	1,034,200	
Site 4	51,900	93,600	24,400
Site 5	23,700	61,600	
Site 6	23,200	67,100	
Channel Improvement	106,300	106,300	
Subtotal	540,100	1,362,800	24,400
d. Total Installation Costs			
Site 3A	2,673,800	6,494,200	
Site 4	480,000	810,600	136,200
Site 5	164,300	265,700	
Site 6	150,200	302,700	
Channel Improvement	504,400	504,400	
Total	3,972,700	8,377,600	136,200

Source: Watershed Investigation Report.

1/ See footnote 1/, Table C-13.

2/ Base year 1967.

Table C-13. Summary of economic impacts generated for the first 10 years after construction begins for Tye River watershed (12-25), James River Basin

Type of Economic Impact	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
	Dollars[7/]		
A. Economic Activity			
1. Destroyed (Annually Indefinitely)[2/]	51,400	103,438	900
a. Generated by agriculture[1/]	23,240	46,769	465[4/]
b. Generated by forest land[1/]	2,460	4,950	0
c. Generated by other activity displaced	0	0	0
d. Multiplier effects (0.5)	12,850	25,860	200
(1.5)	38,550	77,579	700
2. Generated by Use Conservation Activities (once)	7,945,400	16,775,200	272,400
a. Land,[6/] easements & rights of way	671,000	789,000	15,000
b. Construction of structures & services	3,301,700	7,588,600	121,200
c. Multiplier effects (0.5)	1,986,400	4,188,800	68,100
(1.5)	5,959,000	12,566,400	204,300
3. Generated by Annual Operations	33,600	33,600	68,000
a. Operation & maintenance	10,680	10,680	2,170
b. Recreation	1,130	1,130	32,240
c. Water supply	5,000	5,000	0
d. Multiplier effects (0.5)	8,400	8,400	17,200
(1.5)	25,200	25,200	51,600
4. Other Annual Benefits[2/], [3/]	397,400	397,400	
a. Damage reduction	52,680	52,680	[5/]
b. Changed use & redevelopment	124,450	124,450	
c. Local secondary	21,550	21,550	
d. Multiplier effects (1.0)	198,700	198,700	
5. Other Impacts			
a. Church & cemetery relocation			
b. Many residences			

Source: Topographic maps and Watershed Investigation Reports.

1/ Both levels of development assume the same percentage of each type of land in the emergency spillway pool area. The actual percentage at the lower level of development was determined from site maps.
2/ This sum reflects a multiplier effect of 2.0.
3/ Benefits resulting from the higher level of development may be greater than reported here.
4/ This figure is 10 percent of the land area required multiplied by the market value of all agricultural products sold per acre in the watershed.
5/ Changed use and redevelopment resulting from the recreational area were not estimated.
6/ The land cost includes the sale value of the standing timber.
7/ Base year 1967.

partially offset by increased productivity on downstream acres protected from flooding. Dollars lost because of other economic activity destroyed is shown to be zero but can be changed if additional information becomes available. Two multipliers have been applied to the figures.1/

Table 13 also shows the purchase, construction; and multiplier effects of reservoir development. The expenditures and impacts of annual operations are divided into operation and maintenance, recreation and water supply. Recreation consists of incidental recreation on flood control structures unless recreation storage is specified or unless adjacent recreational areas are recommended for development. Water supply impacts are on a development cost basis and must be revalued by local planners based on user charges. Again the 2.0 multiplier was used when totaling first round expenditures and impacts.

Table 13 also lists other annual benefits and their multiplier effects as determined by SCS in their Watershed Investigation Reports. These benefits and their impacts vary widely depending upon local conditions at the time of development and should be reevaluated before development of any site begins.

Other impacts which cannot be assigned an economic value must also be considered. These include disruption of family and religious relationships resulting from residential relocation. Development of site 3A requires relocation of a church and cemetery and many residences. It is difficult to quantify the social costs resulting from the disruptions but these effects must be considered in the evaluation process.

Table 1 presents cost per acre-foot of storage data for each of the reservoir sites in the Tye River watershed. At the lower level of development the average cost per acre-foot of storage is $229, with a range from $152 to $283 per acre-foot. At the upper level of development the average cost is $182 per acre-foot, with a range from $98 to $197. Site 5 is the most expensive site to develop ($282 per acre-foot) and site 6 is the least expensive site ($152 per acre-foot). The water supply storage planned for site 3A costs $214 per acre-foot and the recreation storage planned for site 4 costs $388 per acre-foot. Full development of site 3A increases the water supply storage cost to $260 per acre-foot. Full development of site 4 reduces the recreation storage cost to $353 per acre-foot. Full development of site 5 produces the greatest reduction in storage costs per acre-foot. Planners should use the data in Table 3 when deciding the trade-offs to be made between alternative purposes and costs.

Piney River (12-26)

The impacts resulting from development of the Piney River watershed are summarized in Table 16 and 17. Table 16 presents the land and

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1/ See the introduction to this impact section for a discussion of the use of multipliers.

Table C-14. Summary of levels of development for Piney River watershed (12-26), James River Basin

Specifications or Costs	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
I. Amount of Land Required (acres)			
Site 1A	125	217	
Site 2A	86	93	
Site 3	194	194	40
Total	405	504	40
II. Installation Costs 2/ (dollars)			
a. Land, Easements & Right of Way 1/			
Site 1A	128,000	138,000	
Site 2A	43,000	50,000	
Site 3	85,500	85,500	33,600
Subtotal	256,500	273,500	33,600
b. Construction			
Site 1A	1,103,000	2,164,800	
Site 2A	860,000	1,033,200	
Site 3	605,200	605,200	231,900
Subtotal	2,568,200	3,803,200	231,900
c. Installation Services			
Site 1A	174,500	433,500	
Site 2A	154,600	217,300	
Site 3	96,000	96,000	58,400
Subtotal	425,100	746,800	58,400
d. Total Installation Costs			
Site 1A	1,405,500	2,736,300	
Site 2A	1,057,600	1,300,500	
Site 3	786,700	786,700	323,900
Total	3,249,800	4,823,500	323,900

Source: Watershed Investigation Report.

1/ See Footnote 1/, Table C-15.
2/ Base year 1967.

Table C-15. Summary of economic impacts generated for the first 10 years after construction begins for Piney River watershed (12-26), James River Basin

Type of Economic Impact	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
	Dollars[7]		
A. Economic Activity			
1. Destroyed (Annually Indefinitely)[2]	35,810	44,400	600
a. Generated by agriculture[1]	16,875	20,919	300[4]
b. Generated by forest land[1]	1,030	1,280	0
c. Generated by other activity displaced	0	0	0
d. Multiplier effects (0.5)	8,952	11,100	200
(1.5)	26,857	33,300	400
2. Generated by Use Conservation Activities (once)	6,499,600	9,647,000	647,800
a. Land,[6] easements & rights of way	256,500	273,500	33,600
b. Construction of structures & services	2,993,300	4,550,000	290,300
c. Multiplier effects (0.5)	1,624,900	2,411,800	162,000
(1.5)	4,874,700	7,235,200	485,800
3. Generated by Annual Operations	61,800	61,800	159,000
a. Operation & maintenance	21,520	21,520	5,150
b. Recreation	990	990	74,360
c. Water supply	8,410	8,410	0
d. Multiplier effects (0.5)	15,500	15,500	39,800
(1.5)	46,400	46,400	119,300
4. Other Annual Benefits[2], [3]	313,300	313,300	
a. Damage reduction	63,900	63,900	
b. Changed use & redevelopment	70,880	70,880	5/
c. Local secondary	21,850	21,850	
d. Multiplier effects (1.0)	156,600	156,600	
5. Other Impacts			
a. Many residences			

Source: Topographic maps and Watershed Investigation Reports.

1/ Both levels of development assume the same percentage of each type of land in the emergency spillway pool area. The actual percentage at the lower level of development was determined from site maps.
2/ This sum reflects a multiplier effect of 2.0.
3/ Benefits resulting from the higher level of development may be greater than reported here.
4/ This figure is 10 percent of the land area required multiplied by the market value of all agricultural products sold per acre in the watershed.
5/ Changed use and redevelopment resulting from the recreational area were not estimated.
6/ The land cost includes the sale value of the standing timber.
7/ Base year 1967.

monetary needs necessary for both levels of reservoir development. Table 15 presents the impacts resulting from lost economic activity, reduction in damages and increased spending. The benefits contained in parts 2, 3 and 4 of Table 15 must be compared with the costs presented in Table 15 and parts 1 and 5 of Table 15 to decide whether the benefits outweigh the costs, making it advantageous to develop the watershed.

Development of the watershed to its fullest potential will require that easements be obtained for 504 acres of land, more if access routes and borrow areas are necessary. Easements for only 405 acres of land would be necessary at the lower level of development (to meet identified needs). Examination of Table 14 will indicate the amounts of land and money necessary to develop each site. In this way the local planner can determine the the trade-offs between the costs and benefits of both levels of development. Perhaps it is most advantageous to fully develop only one or two sites, depending on the needs of the community as determined by the planner. Sites 1A and 3 require the greatest amount of land at both the lower level of development and if developed to their fullest potential. Total installation costs are highest for sites 1A and 2A at the lower level of development and for site 1A at the upper level of development.

Table 15 indicates that if the Piney River watershed is developed to its fullest potential, $20,919 of agricultural and $1,280 of forest product sales (1969 yields and prices) will be lost annually because of inundation of productive land. This loss of sales may be wholly or partially offset by increased productivity on downstream acres protected from flooding. Dollars lost because of other economic activity destroyed is shown to be zero but can be changed if additional information becomes available. Two multipliers have been applied to the figures.[1/]

Table 15 also shows the purchase, construction; and multiplier effects of reservoir development. The expenditures and impacts of annual operation are divided into operation and maintenance, recreation and water supply. Recreation consists of incidental recreation on flood control structures unless recreation storage is specified or unless adjacent recreational areas are recommended for development. Water supply impacts are on a development cost basis and must be revalued by local planners based on user charges. Again the 2.0 multiplier was used when totaling first round expenditures and impacts.

Table 15 also lists other annual benefits and their multiplier effects as determined by SCS in their Watershed Investigation Reports. These benfits and their impacts vary widely depending upon local conditions at the time of development and should be reevaluated before development of any site begins.

This watershed is in an excellent location for the development of a large recreational reservoir site. It is located in the middle of

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1/ See the introduction to this impact section for a discussion of the use of multipliers.

the Waynesboro-Charlottesville-Lynchburg triangle and the topography is such that a large pool area is possible.

Other impacts which cannot be assigned an economic value must also be considered. These include disruption of family and religious relationships resulting from residential relocations. Development of this watershed as recommended requires the relocation of many residences. The social costs of these disruptions must be considered.

Table 1 presents cost per acre-foot of storage data for each of the reservoir sites in the Piney River watershed. At the lower level of development the average cost per acre-foot of storage is $241, with a range from $181 to $343 per acre-foot. At the upper level of development the average cost is $203 per acre-foot, with a range from $175 to $362. Site 2A is the most expensive site to develop ($343 per acre-foot) and site 3 is the least expensive site ($181 per acre-foot). The water supply storage planned for site 2A costs $338 per acre-foot and the recreation storage planned for site 3 costs $210 per acre-foot. Full development of site 2A would increase the water supply cost per acre-foot to $364. Full development of site 1A decreases the average cost of storage from $250 to $175 per acre-foot. Full development of site 2A increases the cost per acre-foot of storage. Site 3 is recommended for full development to meet identified needs, thus providing no additional storage capacity for other purposes. Planners should use the data in Table 1 when deciding which trade-offs to make between alternative purposes and costs.

Hardware River (12-30)

The impacts resulting from development of the Hardware River watershed are summarized in Table 16 and 17. Table 16 presents the land and monetary needs necessary for both levels of reservoir development. Table 17 presents the impacts resulting from lost economic activity, reduction in damages and increased spending. The benefits contained in parts 2, 3 and 4 of Table 17 must be compared with the costs presented in Table 18 and parts 1 and 5 of Table 17 to decide whether the benefits outweigh the costs, making it advantageous to develop the watershed.

Development of the watershed to its fullest potential will require that easements be obtained for 1,701 acres of land, more if access routes and borrow areas are necessary. Easements for only 1,079 acres of land would be necessary at the lower level of development (to meet identified needs). Examination of Table 16 will indicate the amounts of land and money necessary to develop each site. In this way the local planner can determine the trade-offs between the costs and benefits of both levels of development. Perhaps it is most advantageous to fully develop only one or two sites, depending on the needs of the community as determined by the planner. Sites 2A and 4 require the greatest amount of land at

Table C-16. Summary of levels of development for Hardware River watershed (12-30), James River Basin

Specifications or Costs	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
I. Amount of Land Required (acres)			
Site 1	86	169	47
Site 2A	257	257	
Site 3	218	365	
Site 4	232	417	52
Site 5	220	375	
Site 6	66	118	
Total	1,079	1,701	99
II. Installation Costs (dollars) 2/			
a. Land, Easements & Right of Way 1/			
Site 1	50,000	100,000	
Site 2A	140,000	140,000	40,200
Site 3	141,500	175,000	
Site 4	136,500	136,500	15,600
Site 5	100,000	165,000	
Site 6	25,000	50,000	
Channel Improvement	30,000	30,000	
Subtotal	623,000	796,500	55,800
b. Construction			
Site 1	175,300	355,500	
Site 2A	306,300	306,300	315,300
Site 3	285,800	392,400	
Site 4	234,900	234,900	119,200
Site 5	191,200	300,100	
Site 6	74,300	226,300	
Channel Improvement	18,500	18,500	
Subtotal	1,286,300	1,834,000	434,500
c. Installation Services			
Site 1	36,300	56,600	
Site 2A	49,200	49,200	79,300
Site 3	63,600	71,100	
Site 4	48,600	48,600	30,000
Site 5	42,500	54,200	
Site 6	22,400	46,700	
Channel Improvement	6,300	6,300	
Subtotal	268,900	332,700	109,300
d. Total Installation Costs			
Site 1	261,600	512,100	
Site 2A	495,500	495,500	434,800
Site 3	490,900	638,500	
Site 4	420,000	420,000	164,800
Site 5	333,700	519,300	
Site 6	121,700	323,000	
Channel Improvement	54,800	54,800	
Total	2,178,200	2,963,200	599,600

Source: Watershed Investigation Report.

1/ See Footnote 1/, Table C-17.
2/ Base year 1967.

Table C-17. Summary of economic impacts generated for the first 10 years after construction begins for Hardware River watershed (12-30), James River Basin

Type of Economic Impact	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
	Dollars[7]		
A. Economic Activity			
1. Destroyed (Annually Indefinietly)[2]	168,280	265,292	1,900
a. Generated by agriculture[1]	82,740	130,436	973[4]
b. Generated by forest land[1]	1,400	2,210	0
c. Generated by other activity displaced	0	0	0
d. Multiplier effects (0.5)	42,070	66,323	500
(1.5)	126,210	198,969	1,500
2. Generated by Use Conservation Activities (once)	4,356,400	5,926,400	1,199,200
a. Land,[6] easements & right of way	623,000	796,500	55,800
b. Construction of structures & services	1,555,200	2,166,700	543,800
c. Multiplier effects (0.5)	1,089,100	1,481,600	299,800
(1.5)	3,267,300	4,444,800	899,400
3. Generated by Annual Operations	100,600	100,600	353,300
a. Operation & maintenance	41,920	41,920	9,840
b. Recreation	1,990	1,990	166,800
c. Water supply	6,400	6,400	0
d. Multiplier effects (0.5)	25,200	25,200	88,300
(1.5)	75,500	75,500	265,000
4. Other Annual Benefits[2], [3]	222,100	222,100	
a. Damage reduction	18,440	18,440	
b. Changed use & redevelopment	66,590	66,590	[5]
c. Local secondary	26,020	26,020	
d. Multiplier effects (1.0)	111,000	111,000	
5. Other Impacts			
a. None			

Source: Topographic maps and Watershed Investigation Reports.

1/ Both levels of development assume the same percentage of each type of land in the emergency spillway pool area. The actual percentage at the lower level of development was determined from site maps.
2/ This sum reflects a multiplier effect of 2.0.
3/ Benefits resulting from the higher level of development may be greater than reported here.
4/ This figure is 10 percent of the land area required multiplied by the market value of all agricultural products sold per acre in the watershed.
5/ Changed use and redevelopment resulting from the recreational area were not estimated.
6/ The land cost includes the sale value of the standing timber.
7/ Base year 1967.

the lower level of development and site 4 requires the greatest land area if developed to its fullest potential. Total installation costs are highest for sites 2A and 3 at the lower level of development and for site 3 at the upper level of development.

Table 17 indicates that if the Hardware River watershed is developed to its fullest potential, $130,436 of agricultural and $2,210 of forest product sales (1969 yields and prices) will be lost annually because of inundation of productive land. This loss of sales may be wholly or partially offset by increased productivity on downstream acres protected from flooding. Dollars lost because of other economic activity destroyed is shown to be zero but can be changed if additional information becomes available. Two multipliers have been applied to the figures[1/].

Table 17 also shows the purchase, construction; and multiplier effects of reservoir development. The expenditures and impacts of annual operations are divided into operation and maintenance, recreation and water supply. Recreation consists of incidental recreation on flood control structures unless recreation storage is specified or unless adjacent recreational areas are recommended for development. Water supply impacts are on a development cost basis and must be revalued by local planners based on user charges. Again the 2.0 multiplier was used when totaling first round expenditures and impacts.

Table 17 also lists other annual benefits and their multiplier effects as determined by SCS in their Watershed Investigation Reports. These benefits and their impacts vary widely depending upon local conditions at the time of development and should be reevaluated before development of any site begins.

Other impacts which cannot be assigned an economic value must also be considered. These include disruption of family and religious relationships resulting from residential relocations. Impacts of this type are of minor importance in this watershed.

Table 1 presents cost per acre-foot of storage data for each of the reservoir sites in the Hardware River watershed. At the lower level of development the average cost per acre-foot of storage is $142, with a range from $92 to $205 per acre-foot. At the upper level of development the average cost is $109 per acre-foot, with a range from $64 to $173. Site 1 is the most expensive site to develop ($205 per acre-foot) and site 5 is the least expensive site ($92 per acre-foot). The water supply storage planned for sites 3 and 5 costs $123 and $93 respectively. The recreation storage planned for sites 2A and 4 costs $224 and $361 per acre-foot respectively. Full development of sites 3 and 5 reduces the

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1/ See the introduction to this impact section for a discussion of the use of multipliers.

water supply storage costs to $68 and $62 per acre-foot respectively. Full development of site 6 increases the cost of storage per acre-foot. Full development decreases the average cost per acre-foot of storage more for site 3 than for any other site, indicating that the greatest cost efficiency of further development occurs in this site. Planners should use the data in Table 1 when deciding which trade-offs to make between alternative purposes and costs.

James River 5 (12-36)

The impacts resulting from development of the James River 5 watershed are summarized in Table 18 and 19. Table 18 presents the land and monetary needs necessary for both levels of reservoir development. Table 19 presents the impacts resulting from lost economic activity, reduction in damages and increased spending. The benefits contained in parts 2, 3, and 4 of Table 19 must be compared with the costs presented in Table 18 and parts 1 and 5 of Table 19 to decide whether the benefits outweigh the costs, making it advantageous to develop the watershed.

Development of the watershed to its fullest potential will require that easements be obtained for 405 acres of land, more if access routes and borrow areas are necessary. Easements for only 189 acres of land would be necessary at the lower level of development (to meet identified needs). Examination of Table 18 will indicate the amounts of land and money necessary to develop each site. In this way the local planner can determine the trade-offs between the costs and benefits of both levels of development. Perhaps it is most advantageous to fully develop only one or two sites, depending on the needs of the community as determined by the planner. Site 4 requires the greatest amount of land at both the lower level of development and if developed to its fullest potential. Total installation costs are highest for site 3B at both the lower level of development and at the upper level of development.

Table 19 indicates that if the James River 5 watershed is developed to its fullest potential, $8,847 of agricultural and $2,760 of forest product sales (1969 yields and prices) will be lost annually because of inundation of productive land. This loss of sales may be wholly or partially offset by increased productivity on downstream acres protected from flooding. Dollars lost because of other economic activity destroyed is shown to be zero but can be changed if additional information becomes available. Two multipliers have been applied to the figures.1/

Table 19 also shows the purchase, construction; and multiplier effects of reservoir development. The expenditures and impacts of annual operations are divided into operation and maintenance, recreation and water supply. Recreation consists of incidental recreation on

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1/ See the introduction to this impact section for a discussion of the use of multipliers.

Table C-18. Summary of levels of development for James River 5 watershed (12-36), James River Basin

Specifications or Costs	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreation Areas
I. Amount of Land Required (acres)			
Site 3B	74	178	
Site 4	110	227	
Total	189	405	(none)
II. Installation Costs2/ (dollars)			
a. Land, Easements & Right of Way 1/			
Site 3B	40,000	56,000	
Site 4	30,000	48,000	
Channel Improvement	7,500	7,500	
Subtotal	77,500	111,500	
b. Construction			
Site 3B	296,100	526,100	
Site 4	188,800	298,300	
Channel Improvement	22,800	22,800	
Subtotal	507,700	847,200	
c. Installation Services			
Site 3B	65,700	94,900	
Site 4	38,900	61,600	
Channel Improvement	7,800	7,800	
Subtotal	112,400	164,300	
d. Total Installation Costs			
Site 3B	401,800	677,000	
Site 4	257,700	407,900	
Channel Improvement	38,100	38,100	
Total	697,600	1,123,000	

Source: Watershed Investigation Report.

1/ See Footnote 1/, Table C-19.
2/ Base year 1967.

Table C-19. Summary of economic impacts generated for the first 10 years after construction begins for James River 5 watershed (12-36), James River Basin

Type of Economic Impact	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
	Dollars [5]		
A. Economic Activity			
1. Destroyed (Annually Indefintely)[2]	10,830	23,214	
a. Generated by agriculture[1]	4,125	8.847	
b. Generated by forest land[1]	1,290	2,760	
c. Generated by other activity displaced	0	0	
d. Multiplier effects (0.5)	2,707	5,803	
(1.5)	8.122	17,410	
2. Generated by Use Conservation Activities (once)	1,395,200	2,246,000	
a. Land,[4] easements & right of way	77,500	111,500	
b. Construction of structures & services	620,100	1,011,500	
c. Multiplier effects (0.5)	348,800	561,500	
(1.5)	1,046,400	1,684,500	
3. Generated by Annual Operations	17,700	17,700	
a. Operation & maintenance	2,000	2,000	
b. Recreation	1,480	1,480	
c. Water Supply	5,380	5,380	
d. Multiplier effects (0.5)	4,400	4,400	
(1.5)	13,300	13,300	
4. Other Annual Benefits[2], [3]	117,800	117,800	
a. Damage reduction	27,800	27,990	
b. Changed use & redevelopment	24,910	24,910	
c. Local secondary	5,980	5,980	
d. Multiplier effects (1.0)	58,900	58,900	
5. Other Impacts			
a. None			

Source: Topographic maps and Watershed Investigation Reports.

1/ Both levels of development assume the same percentage of each type of land in the emergency spillway pool area. The actual percentage at the lower level of development was determined from site maps.
2/ This sum reflects a multiplier effect of 2.0
3/ Benefits resulting from the higher level of development may be greater than reported here.
4/ The land cost includes the sale value of the standing timber.
5/ Base year 1967.

flood control structures unless recreation storage is specified or unless adjacent recreational areas are recommended for development. Water supply impacts are on a development cost basis and must be revalued by local planners based on user charges. Again the 2.0 multiplier was used when totaling first round expenditures and impacts.

Table 19 also lists other annual benefits and their multiplier effects as determined by SCS in their Watershed Investigation Reports. These benefits and their impacts vary widely depending upon local conditions at the time of development and should be reevaluated before development of any site begins.

Other impacts which cannot be assigned an economic value must also be considered. These include disruption of family and religious relationships resulting from residential relocations. Impacts of this type are of minor importance in this watershed.

Table 1 presents cost per acre-foot of storage data for each of the reservoir sites in the James River 5 watershed. At the lower level of development the average cost per acre-foot of storage is \$196, with a range from \$155 to \$212 per acre-foot. At the upper level of development the average cost is \$126 per acre-foot, with a range from \$84 to \$166. Site 3B is the most expensive site to develop (\$212 per acre-foot) and site 4 is the least expensive site (\$155 per acre-foot). The water supply storage planned for site 3B costs \$209 per acre-foot. Full development of the site decreases this cost to \$162 per acre-foot. Full development of site 4 produces the greatest reduction per acre-foot, indicating that the cost benefits of full development are greatest for this site. Planners should use the data in Table 1 when deciding what trade-offs can be made between alternative purposes and costs.

Beaver Creek (12-43)

The impacts resulting from development of the Beaver Creek watershed are summarized in Tables 20 and 21. Table 20 presents the land and monetary needs necessary for both levels of reservoir development. Table 21 presents the impacts resulting from lost economic activity, reduction in damages and increased spending. The benefits contained in parts 2, 3 and 4 of Table 21 must be compared with the costs presented in Table 20 and parts 1 and 5 of Table 21 to decide whether the benefits outweigh the costs, making it advantageous to develop the watershed.

Development of the watershed to its fullest potential will require that easements be obtained for 295 acres of land, more if access routes and borrow areas are necessary. Easements for only 154 acres of land would be necessary at the lower level of development (to meet identified needs). Examination of Table 20 will

Table C-20. Summary of levels of development for Beaver Creek watershed (12-43), James River Basin

Specifications or Costs	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreation Areas
I. Amount of Land Required (acres)			
Site 2	112	198	
Site 7	42	97	
Channel Improvement			
Total	154	295	(none)
II. Installation Costs 2/ (dollars)			
a. Land, Easements & Right of Way 1/			
Site 2	30,000	60,000	
Site 7	7,000	14,000	
Channel Improvement	1,000	1,000	
Subtotal	38,000	75,000	
b. Construction			
Site 2	266,200	482,200	
Site 7	203,100	501,800	
Channel Improvement	3,700	3,700	
Subtotal	473,000	987,700	
c. Installation Services			
Site 2	59,100	87,200	
Site 7	41,900	79,900	
Channel Improvement	1,200	1,200	
Subtotal	101,600	168,300	
d. Total Installation Costs			
Site 2	355,300	629,400	
Site 7	252,000	595,700	
Channel Improvement	5,900	5,900	
Total	613,200	1,231,000	

Source: Watershed Investigation Report.

1/ See Footnote 1/, Table C-21.
2/ Base year 1967.

Table C-21. Summary of economic impacts generated for the first 10 years after construction begins for Beaver Creek watershed (12-43), James River Basin

Type of Economic Impact	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
		Dollars 5/	
A. Economic Activity			
1. Destroyed (Annually Indefinitely) 2/	24,340	46,578	
a. Generated by agriculture 1/	11,880	22,729	(none)
b. Generated by forest land	290	560	
c. Generated by other activity displaced	0	0	
d. Multiplier effects (0.5)	6,085	11,645	
(1.5)	18,255	34,934	
2. Generated by Use Conservation Activities (once) 2/	1,225,200	2,462,000	
a. Land 4/, easements & right of way	38,000	75,000	
b. Construction of Structures & services	574,600	1,156,000	
c. Multiplier effects (0.5)	306,300	615,500	
(1.5)	918,900	1,846,500	
3. Generated by Annual Operations	14,700	14,700	
a. Operation & maintenance	1,500	1,500	
b. Recreation	1,510	1,510	
c. Water Supply	4,320	4,320	
d. Multiplier effects (0.5)	3,700	3,700	
(1.5)	11,000	11,000	
4. Other Annual Benefits 2/ , 3/	67,200	67,200	
a. Damage reduction	8,000	8,000	
b. Changed use & redevelopment	22,010	22,010	
c. Local secondary	3,580	3,580	
d. Multiplier effects (1.0)	33,600	33,600	
5. Other Impacts			
a. None			

1/ Both levels of development assume the same percentage of each type of land in the emergency spillway pool area. The actual percentage at the lower level of development was determined from site maps.
2/ This sum relfects a multiplier effect of 2.0.
3/ Benefits resulting from the higher level of development may be greater then reported here.
4/ The land cost includes the sale value of the standing timber.
5/ Base year 1967.

Source: Topographic maps and Watershed Investigation Reports.

indicate the amounts of land and money necessary to develop each site. In this way the local planner can determine the trade-offs between the costs and benefits of both levels of development. Perhaps it is most advantageous to fully develop only one or two sites, depending on the needs of the community as determined by the planner. Site 2 requires the greatest amount of land at both the lower level of development and if developed to its fullest potential. Total installation costs are also highest for site 2 at both the lower level of development and at the upper level of development.

Table 21 indicates that if the Beaver Creek watershed is developed to its fullest potential $22,729 of agricultural and $560 of forest product sales (1969 yields and prices) will be lost annually because of inundation of productive land. This loss of sales may be wholly or partially offset by increased productivity on downstream acres protected from flooding. Dollars lost because of other economic activity destroyed is shown to be zero but can be changed if additional information becomes available. Two multipliers have been applied to the figures.[1/]

Table 21 also shows the purchase, construction, and multiplier effects of reservoir development. The expenditures and impacts of annual operations are divided into operation and maintenance, recreation and water supply. Recreation consists of incidental recreation on flood control structures unless recreation storage is specified or unless adjacent recreational areas are recommended for development. Water supply impacts are on a development cost basis and must be revalued by local planners based on user charges. Again the 2.0 multiplier was used when totaling first round expenditures and impacts.

Table 21 also lists other annual benefits and their multiplier effects as determined by SCS in their Watershed Investigation Reports. These benefits and their impacts vary widely depending upon local conditions at the time of development and should be reevaluated before development of any site begins.

Other impacts which cannot be assigned an economic value must also be considered. These include disruption of family and religious relationships resulting from residential relocations. Impacts of this type are of minor importance in this watershed.

Table 3 presents cost per acre-foot of storage data for each of the reservoir sites in the Beaver Creek watershed. At the lower level of development the average cost per acre-foot of storage is $199, with a range from $162 to $283 per acre-foot. At the upper level of development the average cost is $163 per acre-foot, with a range from

1/ See the Introduction to this impact section for a discussion of the use of multipliers.

$127 to $230. Site 7 is the most expensive site to develop ($283 per acre-foot) and site 2 is the least expensive site ($162 per acre-foot). The water supply storage planned for site 2 costs $163 per acre-foot. Full development reduces this cost to $126 per acre-foot. Full development of site 2 produced the greatest reduction in cost per acre-foot of storage. Planners should use the data in Table 1 when deciding what trade-offs can be made between alternative purposes and costs.

Calfpasture River (12a-1)

The impacts resulting from development of the Calfpasture River watershed are summarized in Tables 22 and 23. Table 22 presents the land and monetary needs necessary for both levels of reservoir development. Table 23 presents the impacts resulting from lost economic activity, reduction in damages, and increased spending. The benefits contained in parts 2, 3 and 4 of Table 23 must be compared with the costs presented in Table 22 and parts 1 and 5 of Table 23 to decide whether the benefits outweigh the costs, making it advantageous to develop the watershed.

Development of the watershed to its fullest potential will require that easements be obtained for 1,611 acres of land, more if access routes and borrow areas are necessary. Easements for only 835 acres of land would be necessary at the lower level of development (to meet identified needs). Examination of Table 22 will indicate the amounts of land and money necessary to develop each site. In this way the local planner can determine the trade-offs between the costs and benefits of both levels of development. Perhaps it is most advantageous to fully develop only one or two sites, depending on the needs of the community as determined by the planner. Site 7 requires the greatest amount of land both at the lower level of development and if developed to its fullest potential. Total installation costs are highest for site 2C at the lower level of development and for sites 1 and 2C at the upper level of development.

Table 23 indicates that if the Calfpasture River watershed is developed to its fullest potential, $93,776 of agricultural and $4,880 of forest product sales (1969 yields and prices) will be lost annually because of inundation of productive land. This loss of sales may be wholly or partially offset by increased productivity on downstream acres protected from flooding. Dollars lost because of other economic activity destroyed is shown to be zero but can be changed if additional information becomes available. Two multipliers have been applied to the figures.[1/]

Table 23 also shows the purchase, construction; and multiplier effects of reservoir development. The expenditures and impacts of

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1/ See the introduction to this impact section for a discussion of the use of multipliers.

Table C-22. Summary of levels of development for Calfpasture River watershed (12a-1), James River Basin

Specifications or Costs	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
I. Amount of Land Required (acres)			
Site 1	144	247	53
Site 2C	196	355	
Site 3	19	41	
Site 4A	38	95	
Site 5A	35	98	
Site 6	33	69	
Site 7	335	630	
Site 8	35	76	
Total	835	1,611	53
II. Installation Costs (dollars) 2/			
a. Land, Easements & Right of Way 1/			
Site 1	70,000	279,500	10,600
Site 2C	121,500	188,300	
Site 3	15,000	21,800	
Site 4A	5,000	7,000	
Site 5A	33,500	45,200	
Site 6	26,800	11,600	
Site 7	73,000	225,800	
Site 8	11,000	16,000	
Subtotal	355,800	795,200	10,600
b. Construction			
Site 1	595,000	1,597,000	139,600
Site 2C	1,292,700	1,827,800	
Site 3	276,400	329,300	
Site 4A	332,600	806,300	
Site 5A	175,000	666,400	
Site 6	140,000	325,700	
Site 7	113,800	267,200	
Site 8	539,600	998,300	
Subtotal	3,465,100	6,818,000	139,600
c. Installation Services			
Site 1	94,200	254,000	35,100
Site 2C	230,600	329,100	
Site 3	57,000	52,500	
Site 4A	52,700	127,800	
Site 5A	36,100	105,600	
Site 6	28,900	51,600	
Site 7	21,400	50,400	
Site 8	85,400	158,200	
Subtotal	606,300	1,129,200	35,100
d. Total Installation Costs			
Site 1	759,200	2,130,500	185,300
Site 2C	1,644,800	2,345,200	
Site 3	348,400	403,600	
Site 4A	390,300	941,100	
Site 5A	244,600	817,200	
Site 6	195,700	388,900	
Site 7	208,200	543,400	
Site 8	636,000	1,172,500	
Total	4,427,200	8,742,400	185,300

Source: Watershed Investigation Reports.

1/ See Footnote 1/, Table C-23.
2/ Base year 1967.

Table C-23. Summary of economic impacts generated for the first 10 years after construction begins for Calfpasture River watershed (12a-1), James River Basin

Type of Economic Impact	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
		Dollars 7/	
A. Economic Activity			
1. Destroyed (Annually Indefinitely)2/	101,380	197,312	1,700
a. Generated by agriculture1/	48,160	93,776	868 4/
b. Generated by forest land1/	2,530	4,880	0
c. Generated by other activity displaced	0	0	0
d. Multiplier effects (0.5)	23,345	49,328	400
(1.5)	76,035	147,984	1,300
2. Generated by Use Conservation Activities (once)	8,854,400	17,484,800	370,600
a. Land6/, Easements & Right of Way	355,800	795,200	10,600
b. Construction of Structures & services	4,071,400	7,947,200	174,700
c. Multiplier effects (0.5)	2,213,600	4,371,200	92,600
(1.5)	6,640,800	13,113,600	278,000
3. Generated by Annual Operations	77,700	77.700	67,200
a. Operation & maintenance	13,320	13,320	1,810
b. Recreation	3,770	3,770	31,800
c. Water Supply	21,770	21,770	0
d. Multiplier effects (0.5)	19,400	19,400	16,800
(1.5)	58,300	58,300	50,400
4. Other Annual Benefits2/, 3/	407,100	407,100	
a. Damage reduction	106,830	106,830	
b. Changed use & redevelopment	72,980	72,980	
c. Local secondary	23,720	23,720	5/
d. Multiplier effects (1.0)	203,500	203,500	
5. Other Impacts			
a. Many residences			
b. Much highway relocation			

Source: Topographic maps and Watershed Investigation Reports

1/ Both levels of development assume the same percentage of each type of land in the emergency spillway pool area. The actual percentage at the lower level of development was determined from site maps.
2/ This sum reflects a multiplier effect of 2.0.
3/ Benefits resulting from the higher level of development may be greater than reported here.
4/ This figure is 10 percent of the land area required multiplied by the market value of all agricultural products sold per acre in the watershed.
5/ Changed use and redevelopment resulting from the recreational area were not estimated.
6/ The land cost includes the sale value of the standing timber.
7/ Base year 1967.

annual operations are divided into operation and maintenance, recreation and water supply. Recreation consists of incidental recreation on flood control structures unless recreation storage is specified or unless adjacent recreational areas are recommended for development. Water supply impacts are on a development cost basis and must be revalued by local planners based on user charges. Again the 2.0 multiplier was used when totaling first round expenditures and impacts.

Table 23 also lists other annual benefits and their multiplier effects determined the SCS in their Watershed Investigation Reports. These benfits and their impacts vary widely depending upon local conditions at the time of development and should be reevaluated before development of any site begins.

Other impacts which cannot be assigned an economic value must also be considered. These include disruption of family and religious relationships resulting from residential relocations. Development of this watershed involves relocation of several residences and highway sections. The social costs of these disruptions must be considered with other costs and benefits during the decision-making process.

Table 1 presents the cost per acre-foot of storage data for each of the reservoir sites in the Calfpasture River watershed. At the lower level of development the average cost per acre-foot of storage is $312, with a range from $71 to $882 per acre-foot. At the upper level of development the average cost is $195 per acre-foot, with a range from $53 to $350. Site 3 is the most expensive site to develop ($882 per acre-foot) and site 7 is the least expensive site ($71 per acre-foot). The water-supply storage planned for site 2C costs $296 per acre-foot and the recreation storage planned for site 1 costs $1,163 per acre-foot. Full development reduces these costs to $156 and $1,112 per acre-foot respectively. Full development of site 3 reduces the average cost of storgae for all purposes dramatically, from $882 to $299 per acre-foot, indicating that the greatest cost benefits from full development occur in this site. Planners should use the data in Table 3 when deciding what trade-offs can be made between alternative purposes and costs.

North Fork Rivanna River (12b-1, 2, 7, 12)

The impacts resulting from development of the North Fork Rivanna River watershed are summarized in Table 24 and 25. Table 24 presents the land and monetary needs necessary for both levels of reservoir development. Table 25 presents the impacts resulting from lost economic activity, reduction in damages and increased spending. The benefits contained in parts 2, 3, and 4 of Table 25 must be compared with the costs presented in Table 24 and parts 1 and 5 of Table 25 to decide whether the benefits outweigh the costs, making it advantageous to develop the watershed.

Table C-24. Summary of levels of development for North Fork Rivanna River (12-1,2,7,12), James River Basin

Specifications or Costs	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
I. Amount of Land Required (acres)			
Site 3	420	811	
Site 1C	290	520	
Site 1	330	490	
Site 2	74	140	
Site 3	118	204	
Site 6A	141	258	
Site 11	858	1,318	200
Total	2,231	3,741	200
II. Installation Costs (dollars) 2/			
a. Land, Easements & Right of Way 1/			
Site 3	160,000	392,000	
Site 1C	64,500	112,200	
Site 1	180,800	303,700	
Site 2	20,000	48,000	
Site 3	35,000	84,000	
Site 6A	40,000	96,000	
Site 11	352,000	668,800	81,500
Total	852,300	1,704,700	81,500
b. Construction			
Site 3	479,600	1,175,100	
Site 1C	182,000	299,000	
Site 1	376,200	632,100	
Site 2	76,900	184,500	
Site 3	133,100	319,400	
Site 6A	187,800	450,800	
Site 11	845,000	1,605,400	512,200
Total	2,280,600	4,666,300	512,200
c. Installation Services			
Site 3	86,900	213,300	
Site 1C	36,500	69,400	
Site 1	68,300	114,700	
Site 2	23,200	38,400	
Site 3	27,600	51,100	
Site 6A	39,000	72,100	
Site 11	136,400	258,900	128,600
Subtotal	417,900	817,900	128,600
d. Total Installation Costs			
Site 3	726,500	1,780,400	
Site 1C	283,000	480,600	
Site 1	625,300	1,050,500	
Site 2	120,100	270,900	
Site 3	195,700	454,500	
Site 6A	266,800	618,900	
Site 11	1,333,400	2,533,100	722,300
Total	3,550,800	7,911.200	722,300

Source: Watershed Investigation Reports.

1/ See Footnote 1/, Table C-25.
2/ Base year 1967.

Table C-25. Summary of economic impacts generated for the first 10 years after construction begins for North Fork Rivanna River (12-1,2,7,12), James River Basin

Type of Economic Impact	Development to Meet Identified Needs	Full Development Potential	Adjacent Recreational Areas
		Dollars 6/	
A. Economic Activity			
1. Destroyed (Annually Indefinitely) 2/	324,852	536,000	4,000
a. Generated by agriculture 1/	155,346	256,128	2,000
b. Generated by forest land 1/	7,080	11,870	0
c. Generated by other activity displaced	0	0	0
d. Multiplier effects (0.5)	81,213	134,000	1,000
(1.5)	243,639	402,000	3,000
2. Generated by Use Conversion Activities once 2/	7,101,600	14,377,800	1,444,600
a. Land, Easements & Right of Way	852,300	1,704,700	81,500
b. Construction of structures & services	2,698,500	5,484,200	640,800
c. Multiplier effects (0.5)	1,775,400	3,594,400	361,200
(1.5)	5,326,200	10,783,400	1,083,400
3. Generated by Annual Operations	128,100	128,100	378,500
a. Operation & Maintenance	50,630	50,630	12,200
b. Recreation	1,100	1,100	177,060
c. Water Supply	12,310	12,310	0
d. Multiplier effects (0.5)	32,000	32,000	94,600
(1.5)	96,100	96,100	283,900
4. Other Annual Benefits 2/, 3/	311,900	311,900	
a. Damage reduction	61,900	61,900	
b. Changed use & redevelopment	62,570	62,570	
c. Local secondary	31,500	31,500	
d. Multiplier effects (1.0)	156,000	156,000	5/
5. Other Impacts			
a. Cemetery access			
b. Several residences			
c. Much highway relocation			

Source: Topographic maps and Watershed Investigation Reports.

1/ Both levels of development assume the same percentage of agricultural land in the emergency spillway pool area. The actual percentage at the lower level of development was determined from site maps.

2/ This sum includes the multiplier effects of 2.0 shown below.

3/ Benefits resulting from the higher level of development may be greater than reported here.

4/ This figure is 10 percent of the land area required multiplied the value of all agricultural products sold per acre in the watershed.

5/ Changed use and redevelopment resulting from the recreational area were not estimated.

6/ Base year 1967.

Development of the watershed to its fullest potential will require that easements be obtained for 3,741 acres of land, more if access routes and borrow areas are necessary. Easements for only 2,231 acres of land would be necessary at the lower level of development (to meet identified needs). Examination of Table 24 will indicate the amounts of land and money necessary to develop each site. In this way the local planner can determine the trade-offs between the costs and benefits of both levels of development. Perhaps it is most advantageous to fully develop only one or two sites, depending on the needs of the community as determined by the planner. Site 11 requires the greatest amount of land at both the lower level of development and if developed to its fullest potential. Total installation costs are also highest for site 11 at both the lower level of development and at the upper level of development.

Table 25 indicates that if the North Fork Rivanna River watershed is developed to its fullest potential, $256,128 of agricultural and $11,870 of forest product sales (1969 yields and prices) will be lost annually because of inundation of productive land. This loss of sales may be wholly or partially offset by increased productivity on downstream acres protected from flooding. Dollars lost because of other economic activity destroyed is shown to be zero but can be changed if additional information becomes available. Two multipliers have been applied to the figures.1/

Table 25 also shows the purchase, construction; and multiplier effects of reservoir development. The expenditures and impacts of annual operations are divided into operation and maintenance, recreation and water supply. Recreation consists of incidental recreation on flood control structures unless recreation storage is specified or unless adjacent recreational areas are recommended for development. Water supply impacts are on a development cost basis and must be revalued by local planners based on user charges. Again the 2.0 multiplier was used when totaling first round expenditures and impacts.

Table 25 also lists other annual benefits and their multiplier effects as determined by SCS in their Watershed Investigation Reports. These benefits and their impacts vary widely depending upon local conditions at the time of development and should be reevaluated before development of any site begins.

Other impacts which cannot be assigned an economic value must also be considered. These include disruption of family and religious relationships resulting from residential relocations. Development of this watershed will necessitate relocation of a cemetery access and many residences. There is also much highway relocation involved, resulting in disruption

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1/ See the introduction to this impact section for a discussion of the use of multipliers.

of travel patterns for many people. The social effects, although difficult to quantify, must be considered when balancing benefits and costs.

Table 1 presents cost per acre-foot of storage data for each of the reservoir sites in the North Fork Rivanna River Watershed. At the lower level of development the average cost per acre-foot of storage is $92, with a range from $61 to $133 per acre-foot. At the upper level of development the average cost is $89 per acre-foot, with a range from $43 to $122. Site 2(12b-7) is the most expensive site to develop ($133 per acre-foot) and site 1C(12b-2) is the least expensive site ($61 per avre-foot). The water supply storage is planned for sites 3(12b-1) and 1(12b-7) costs $87 and $90 per acre-foot respectively. Full development reduces the cost of water supply in site 3(12b-1) to $71 per acre-foot. The recreation storage planned for site 11 costs $124 per acre-foot. Full development increases this cost to $137 per acre-foot. Full development of site 1(12b01) produces the greatest reduction in average cost per acre-foot of storage. Full development increases the average cost of storages in site 11(12b-12). Planners should use the data in Table 1 when deciding what trade-offs can be made between alternative purposes and costs.

Intermediate Action Projects

Nine projects containing 20 CNI watershed are planned to be developed during a period from 1980 to year 2000. These nine projects will provide flood prevention benefits of $1,317,600, water supply benefits of $125,700, recreation benefits of $2,525,300, and redevelopment and secondary benefits of $498,500 for a total of $4,467,100 annually. Total project cost, including operation and maintenance, is $3,233,300 annually, giving a benefit-cost ratio of 1.4:1 (Table C-26).

Nineteen structures are planned for single purpose flood prevention. Thirteen structures will contain 20,870 acre-feet for municipal water storage and 13 will provide storage and basic facilities for public recreation. A total of 5,554 surface acres will be available for public recreation with basic facilities designed to accomodate 45,136 persons. The total visitation expected to approximately 2,256,000 persons annually.

Long Range Projects

Five projects containing nine CNI watersheds are to be developed between the year 2000 and 2020. These projects provide total benefits of $2,142,500 annually. Total project cost, including operation and maintenance is $1,491,700 annually, giving a benefit-cost ratio of 1.4:1 (Table C-26).

A total of 17 structures are planned in the long range program; 10 single purpose flood prevention, 2 municipal water supply, and 5 public recreation. The 5 recreation structures will provide 3,304 surface acres with basic facility demand capacity to accomodate 26,984 persons.

Table C-26. Average annual benefits and cost, PL-566 projects, Intermediate and Long Range Action, Price Base 1967, James River Basin

Watershed	Benefits: Flood 1/ Prevention	Benefits: Water Supply	Benefits: Recreation	Benefits: Redev. & Secondary	Benefits: Total Benefits	Total Average Annual Costs: 5-5/8%	Total Average Annual Costs: 5-7/8%	Total Average Annual Costs: 7	Benefit - Cost Ratio: 5-5/8%	Benefit - Cost Ratio: 5-7/8%	Benefit - Cost Ratio: 7
	Thousands of Dollars										
Intermediate Action											
Potts Creek, 12-9,10,11	125.3	14.5	134.7	78.4	352.9	320.7	332.8	387.2	1.10:1	1.06:1	0.91:1
Catawba Creek, 12-22	111.6	63.3	76.2	75.7	326.8	302.3	314.4	369.0	1.08:1	1.04:1	0.89:1
Rockfish River, 12-23,24	141.3	4.3	280.2	42.6	468.4	382.9	395.6	453.2	1.22:1	1.18:1	1.03:1
Beaverdam Creek, 12-50	29.1	7.3	172.2	20.9	229.5	161.8	166.5	187.5	1.42:1	1.38:1	1.22:1
Hays Creek, 12a-3	89.0	2.9	-	9.2	101.1	110.2	115.0	136.5	0.92:1	0.88:1	0.74:1
South River, 12a-6	206.4	22.5	-	22.9	251.8	272.1	283.7	336.4	0.93:1	0.89:1	0.75:1
South Fork Rivanna River, 12b-3,4,5,6,13,14	190.8	8.4	301.1	50.0	550.3	503.2	520.8	600.5	1.09:1	1.06:1	0.92:1
Upper Appomattox River, 12c-1,2,12	183.7	2.5	276.3	46.3	508.8	343.7	354.5	403.4	1.48:1	1.44:1	1.26:1
Middle Appomattox River, 12c-3,4	240.4	-	1,284.6	152.5	1,677.5	1,193.5	1,227.3	1,380.0	1.41:1	1.37:1	1.22:1
Subtotal	1,317.6	225.7	2,525.3	498.5	4,467.1	3,590.4	3,710.6	4,253.7	x	x	x
Long Range Action											
Bent Creek, 12-41	11.0	-	119.0	13.0	143.0	111.2	114.3	128.7	1.29:1	1.25:1	1.11:1
Wreck Island Creek, 12-42	49.2	-	168.4	21.8	239.4	169.8	175.0	198.3	1.41:1	1.37:1	1.21:1
Byrd Creek, 12-44	70.3	-	157.2	22.8	250.3	169.7	174.8	198.0	1.47:1	1.43:1	1.26:1
Lower Appomattox River, 12c-5,8	208.1	-	-	20.8	228.9	241.9	252.0	297.7	0.95:1	0.91:1	0.77:1
Deep Creek-Flat Creek, 12e-6,9,13,14	175.8	19.5	969.2	116.4	1,280.9	888.8	916.2	1,040.4	1.44:1	1.40:1	1.23:1
Subtotal	514.4	19.5	1,413.8	194.8	2,142.5	1,581.4	1,632.3	1,863.1			

1/ Flood prevention benefits includes damage reduction, more intensive land use, changed land use, incidental recreation and benefits to sediment stored in structures.
2/ 100-year amortization rate.

APPENDIX D. METHODOLOGY

Land Use Categories and Projection Methodology

The land use categories considered include cropland, pasture and forest land, other independent cities and urban areas, and water area.

The cropland category includes cropland harvested, crop failures, summer fallow, idle cropland, cropland in cover crops or soil-improvement crops not harvested or pastured, rotation pasture and cropland being prepared for crops. All tame hay was included as cropland.

Cropland

Cropland acres were projected through the use of an exponential function. This procedure was used because it seemed to best fit the trend in the use of cropland and pasture acres shown by the 1949, 1954, 1959 and 1964 editions of the Census of Agriculture. The exponential function used for these projections sloped downward to the right with the ususal decreasing rate of change. The specific form of each function was determined by fitting it to the cropland (or pasture in the case of pasture acre projections) acres shown in each of the census years mentioned above. Using this function, acres in cropland (or pasture) were projected for the years 1958, 1967, 1980, 2000, and 2020. The next step was to compare cropland (or pasture) acres shown in 1958 and preliminary 1957 Conservation Needs Inventory studies to the projections made for 1958 and 1967 using census data. The average percentage difference between the two figures for each of the two years was determined and then used to adjust the projections made for 1980, 2000 and 2020. In essence, Census of Agriculture trends in cropland (or pasture) acres were adjusted by Conservation Needs Inventory data.

Pasture

The pasture category includes land in grass that is used primarily for grazing. Pasture includes all grazing land with the exception of pasture in crop rotation. It may include shade trees or scattered timber trees with less than 10 percent canopy, but the principal plant cover is such as to identify its use primarily as permanent grazing land.

The same method of projections was used for pasture acres as was used for cropland acres.

Forest Land

Forest land includes lands which are at least 10 percent stocked by forest trees of any size and capable of producing timber

or other wood products, or capable of exerting influence on the water regime; lands from which such trees have been removed to less than 10 percent stocking and which have not been developed for other uses; and areas that have been planted to trees. Both public and private forest lands are included. Forest land acreage projections were made by the United States Forest Service.

Other Land

Other land includes farmsteads, idle land, wildlife areas and other areas not classified into cropland, pasture, forest land, and independent cities and urban areas. Idle land includes only land formerly used for crops and pasture, now abandoned and not yet reforested or put to other use. Included are such areas as crossroad stores and filling stations, rural non-farm residential sites, church and school grounds, and similar built-up areas of less than 100 acres.

"Other acres" serve as a catch-all for acres which did not fit into any of the other categories.

Independent Cities and Urban Areas

Acres in independent cities and urban areas include independent cities, unincorporated cities and villages, industrial sites and other built-up areas, railroads and highways, cemeteries, airports and golf courses.

Acres in this category were subjectively projected by looking at the size of the appropriate urban centers and the activity generated by them.

Water

The water area was determined by the Soil Conservation Service using Conservation Needs Inventory data and topographic maps. The 1967 water acres were assumed constant in the projection years since it is the purpose of the overall study to determine the need for the development of the water resources. Upon completion of plan formulation, water area will be increased accordingly.

Total land and water area is the sum of the previously defined categories. The total acreage will only approximate the acreage found using hydrologic boundaries due to the adherence to county boundaries.

Methodology Used to Project Water Requirements

Livestock Water Requirements

The numbers of cattle and calves, milk cows, hogs and pigs, sheep and lambs and chickens and turkeys were obtained by county from the Census of Agriculture for 1949, 1954, 1959, and 1964. These historical figures were then projected by linear regression techniques. Subjective adjustments were necessary when the linear projection of historical numbers resulted in negative numbers in projection years.

Then following consumptive use co-efficients developed for the North Atlantic Region Study were applied to determine total annual projected livestock water requirements.

Milk Cows	25	gallons	per	day	per	head
Cattle & Calves	10	"	"	"	"	"
Hogs & pigs	3	"	"	"	"	"
Sheep & Lambs	2	"	"	"	"	"
Chickens	.04	"	"	"	"	"
Turkeys	.06	"	"	"	"	"

Domestic Water Requirements

Consumptive use co-efficients developed for the North Atlantic Region Study were applied to population projections to determine projected total annual domestic water requirements. The 1960 Census of Housing data were used to adjust 1980 projections to reflect rural households without running water. It was assumed that by 2000 all households would have running water.

Rural Farm Consumptive Use Co-Efficients

1980 (with running water)	74 gallons per day per person
1980 (without running water)	10 gallons per day per person
2000	95 gallons per day per person
2020	95 gallons per day per person

Rural Non-farm Consumptive Use Co-Efficients

1980 (with running water)	100 gallons per day per person
1980 (without running water)	10 gallons per day per person
2000	119 gallons per day per person
2020	123 gallons per day per person

Urban Consumptive Use Co-Efficients

1980	115 gallons per day per person
2000	138 gallons per day per person
2020	167 gallons per day per person

USDA-SCS-HYATTSVILLE, MD. 1974